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A SYSTEMATIC ANALYSIS OF VARIATION IN THE WESTERN AMERICAN PIPEFISH, *SYNGNATHUS CALIFORNIENSIS*

By Earl Stannard Herald

INTRODUCTION

Preliminary to the preparation of a monograph of the American species of pefishes it seemed advisable to study the variation within a single species. cause of the confusion regarding the systematic status of *Syngnathus californensis* and its several related forms and because of the large amount of material ailable, this species seemed best suited for this purpose. Only one detailed udy of intraspecific variation in pipefishes has heretofore been made. Duncker 908) has studied the modifications of *Syngnathus typhle* at three main localies, the Baltic Sea, Plymouth, England, and Naples, Italy.

Aside from the original descriptions, very little has been written concerng American pipefishes of the Pacific coast. Gill (1862) listed the species then own. Jordan and Evermann (1898: 760) gave good descriptions and keys to the ecies of the Pacific coast. Starks and Morris (1907) pointed out the hitherto known variation in specimens of *Syngnathus auliscus* from San Diego. Duncker 915), in his revision of the Syngnathidae, did not include any of the western rth American species, although the literature referring to them is to be found his bibliography; however, he listed the genus *Dermatostethus* as a synonym of *ngnathus*. This is important in view of the fact that Jordan, Evermann and Clark 930) doubtfully reinstated *Dermatostethus*. Hubbs (1916) listed specimens of *ngnathus leptorhynchus* from Anaheim Bay, Orange County, and from San Diego Bay, lifornia, which were quite different from those on which the original descripon was based. Later (1921b) he placed *barbarae* as a synonym of *leptorhynchus*, inting out the fact that the former was most probably a *leptorhynchus* with an jured tail. Also, in tabular form he showed some of the variation present within e species *griseo-lineatus* and *californiensis*. Jordan, Evermann and Clark in their 30 "Check List" recorded the known West Coast pipefishes and in addition reinated *Syngnathus arundinaceus* (=*griseo-lineatus*) and *S. barbarae* (=*leptorhynchus*), well as the previously mentioned *Dermatostethus ~~punctipinnis~~* (=*S. californiensis*). Barnhart (1936) gave short descriptions of the four species of southern lifornia pipefishes. Herald (1940) listed and gave keys to the Pacific American rms, in addition to the description of two new genera and species from the same ea.

Until this time there have been recognized in the literature five valid

species of pipefishes on the Pacific coast north of Mexico. *Syngnathus arctus* (o which a single specimen was recently taken at Tomales Bay, California) and *auliscu* range as far north as San Pedro, California; they differ from the remaining grou of species in that they never have more than 16 (usually 15) body rings. To th *californiensis* group belong the following: the kelp pipefish, *S. californiensis*, which occurs in kelp along the open coast and but rarely in bays, ranging fro Ballenas Bay, Lower California, north to Monterey and San Francisco Bays; th southern bay pipefish, *S. leptorhynchus*, which occurs in eel-grass of shallow bay and sloughs from Ensenada, Lower California, north to Morro Bay, California; an the northern bay pipefish, *S. griseo-lineatus*, which occurs in eelgrass from Elk horn Slough, Monterey Bay, California, north to Sitka, Alaska. A related fossil form, *S. avus*, from the Miocene of southern California has also been described. I is with this *californiensis* complex that the present paper deals, the study being based upon a critical examination of 1,915 specimens (128 of *californiensis*, 784 of *griseo-lineatus* and 1,003 of *leptorhynchus*). An attempt has been made to learn just what effects changes of latitude and of water temperature may have upon the dif ferent members of the group. In addition, by studying the sexual and growth varia tion, it is hoped that the important taxonomic characters have been evaluated and a knowledge gained of the structures involved in incubation.

ACKNOWLEDGMENTS

I am indebted to the following persons for aid in the loan of material, in the examination of types, in making collections or in giving valuable aid and ad vice: Dr. Paul Chabanaud of the Paris Museum, Dr. Raymond B. Cowles of the Uni versity of California at Los Angeles, Mr. W. I. Follett of Oakland, California, Dr. Carl Hubbs and Mr. Robert R. Miller of the Museum of Zoology of the University of Michigan, the late Dr. Joseph Grinnell, Dr. E. Raymond Hall and Dr. Alden Miller, all of the Museum of Vertebrate Zoology of the University of California, Dr. George S. Myers and Dr. Willis Rich of the Natural History Museum of Stanford University, Dr. Leonard P. Schultz of the United States National Museum, Dr. H. U. Sverdrup of the Scripps Institution of Oceanography, Mr. Arthur D. Welander of the Univer sity of Washington and Dr. Sherwin F. Wood of Los Angeles City College.

METHODS

The method used has been to analyze samples of populations at each locality from which material was available and to compare these population data statisti cally.

Four principal characters have been used throughout this study: (1) the number of rays in the dorsal fin, (2) the number of trunk rings, (3) the number of tail rings, and (4) the number of rings covered by the brood pouch, a structure which is found in the male only and which lies on the underside of the tail. The characters will be considered in the order here given.

All rays which are visible in the dorsal fin above the surface of the back were counted. Extreme care must be taken that all of the posterior rays are in cluded in the count. The last one or two usually are hidden by a fold of the fin, and frequently are overlooked, even by competent ichthyologists. Fin-ray counts for other than the dorsal fin are remarkably constant: anal 3, caudal 10, pectoral 11 to 14 (usually 12 for the bay forms and 13 or 14 for the kelp form). About 25 per

nt of the specimens are found to have a different count for right and left pec-ral fins, for example: 11, 12; 11, 13; 12, 13.

In counting the rings of the trunk, the ring bearing the pectoral fins is unted as number one. Actually, according to Jungersen (1910), this scapular ring composed of the elements of two rings. The last trunk ring is that one which ntains the anus. The usual position of the anus is on the posterior part of this st trunk ring, and very rarely on the center or anterior part of it. The anal fin es just caudad of the anus, and its usual position is on the anterior part of the rst tail ring. When the anus appears to lie between two segments, the anterior of e two rings is counted as the anal or last trunk ring.

The tail ring count begins with the ring following the anal ring and is con-uded on the ring in front of the hypural ring. The reason for this is that the st posterior rings, although readily visible in large specimens, are so tele-oped in small specimens that they may be overlooked. By completing the count on e ring before the hypural ring, this error is minimized.

The count of the rings covered by the brood pouch usually begins with the rst tail ring and extends to the most caudad limit of the brood cavity; exter-lly the pouch may appear to extend beyond the internal cavity, but the end of the tter is taken as the point of reference in counting. Occasionally, in a well-lled pouch, the first pouch ring is the anal ring and not, as usual, the first il ring; in this case the eggs may be present on both sides of, and laterally in ont of, the anus. Thus the count may be written 1 plus 20, if it is wished to dicate the extent of the pouch on the trunk as well as on the tail, or 21 to dicate the total count.

After having determined that color has no value taxonomically within the ecies, it was no longer considered. Three colors are common: green, gray, and own. Red and other colors do not occur.

A character used by Jordan and Evermann (1898: 764) to distinguish *californiensis* and *leptorhynchus* was: "dorsal fin shorter than the head." This did not ove to be useful when 80 specimens of *leptorhynchus* from Point Mugu, Ventura unty, California, were measured. In 14 of the specimens (17.5 per cent) the dor-l fin was either equal to or longer than the head. There were 11 individuals with ad and dorsal equal in length and three with the dorsal longer than the head. The ason for this variation is apparent when the snout-head growth change is studied. is relationship is presented in the following section.

SEXUAL AND GROWTH VARIATION

The chief external sexual difference in the pipefishes of the "Urophori" oup (as defined by Duncker) is the presence of a brood pouch on the under side the tail of the male; this is absent in the female. Rauther (1925) found that in e seahorses in the Gulf of Naples most of the females of *brevirostris* and a num-er of the females of *guttulatus* had the brood pouch developed, even though in dimentary form. Duncker (1908) has figured a female of *Syngnathus agassizii* (Pl. Fig. 7) with the ovaries turgid with eggs and with a partly developed pouch. No rtain examples have been found of female pipefishes of the *californiensis* group th any development of the brood pouch. But from various localities there are rge specimens (170 mm. or greater) which show a dark, wide groove under the tail—e first indication of the formation of the brood pouch; all of these individuals ve undeveloped gonads, even though taken in the height of the breeding season. cause of the size of the specimens, the undeveloped state of the gonads, and the

darkened area under the tail, these fishes may correspond to the so-called pseud hermaphroditic individuals of Rauther and Duncker, but the proof of this will ha to await a cytological examination of the gonads.

Before deciding upon characters to be used in this analysis it was nece sary first to know whether differences other than that of the brood pouch exist between males and females. For a comparative study, 36 males and 35 females fr Point Mugu Lagoon, Ventura County, California, were selected. Both males and femal were mature sexually, that is, they showed upon dissection either well develope brood pouches or eggs in the ovaries. The data are shown in Table 1.

Table 1. Average meristic counts for males and females from Point Mugu, Californi

	Males	Females
Number of Specimens	36.0	35.0
Body Rings	18.20	18.06
Tail Rings	39.60	39.77
Dorsal Fin Rays	33.68	34.05

These differences are not considered great enough to warrant testing statis tically. But when measurements of trunk and tail are taken in millimeters, an the former divided by the latter, it is found that there is a decided differenc between males and females as shown by Table 2. Thus, although there is no differ ence in the number of tail rings between the two sexes, the individual tail ring on the male are longer. It is probable that the brood pouch of the male is respon sible for the increased length of the segments. The tail-in-trunk average for male was found to be .476 and for females, .519.

Table 2. Tail-in-trunk values for males and females from Point Mugu, California

Tail-in-trunk	.43	.44	.45	.46	.47	.48	.49	.50	.51	.52	.53	.54	.55	.56	.5
Males	1	0	2	4	7	10	10	2							
Females						1	3	8	6	4	5	1	3	2	2

In Fig. 1 it should be noted that this relationship of tail to trunk does not change with growth, as is the case with the snout-in-head length, which will be discussed later. The tail has been compared with the trunk, and has not been compared with the standard length, as has been done by most ichthyologists who have worked on pipefishes. If the tails of males and females were compared by taking this structure as a part of the standard length, the result would be satisfactory only if there were no differential growth or sexual differences in the head or the trunk, but should those differences be present, then the result would be to increase or decrease the differences between the tails.

When snout-in-head is graphed against the standard length in millimeters, a curve results, as shown in Fig. 2. There is no difference between males and females in this character. The kelp subspecies and the northern bay subspecies have also been included upon this graph; it is apparent that these forms follow the same curve, but that the snouts average longer than in the correspondingly-sized southern bay pipefish. The *griseo-lineatus* specimens are mostly from northern California. The *californiensis* specimens are not from any specific locality, but are taken from throughout the range; this should be allowable since there is not much variation between specimens from northern and southern limits of the range.

D'Ancona (1934) has figured specimens of *Syngnathus typhle* showing the

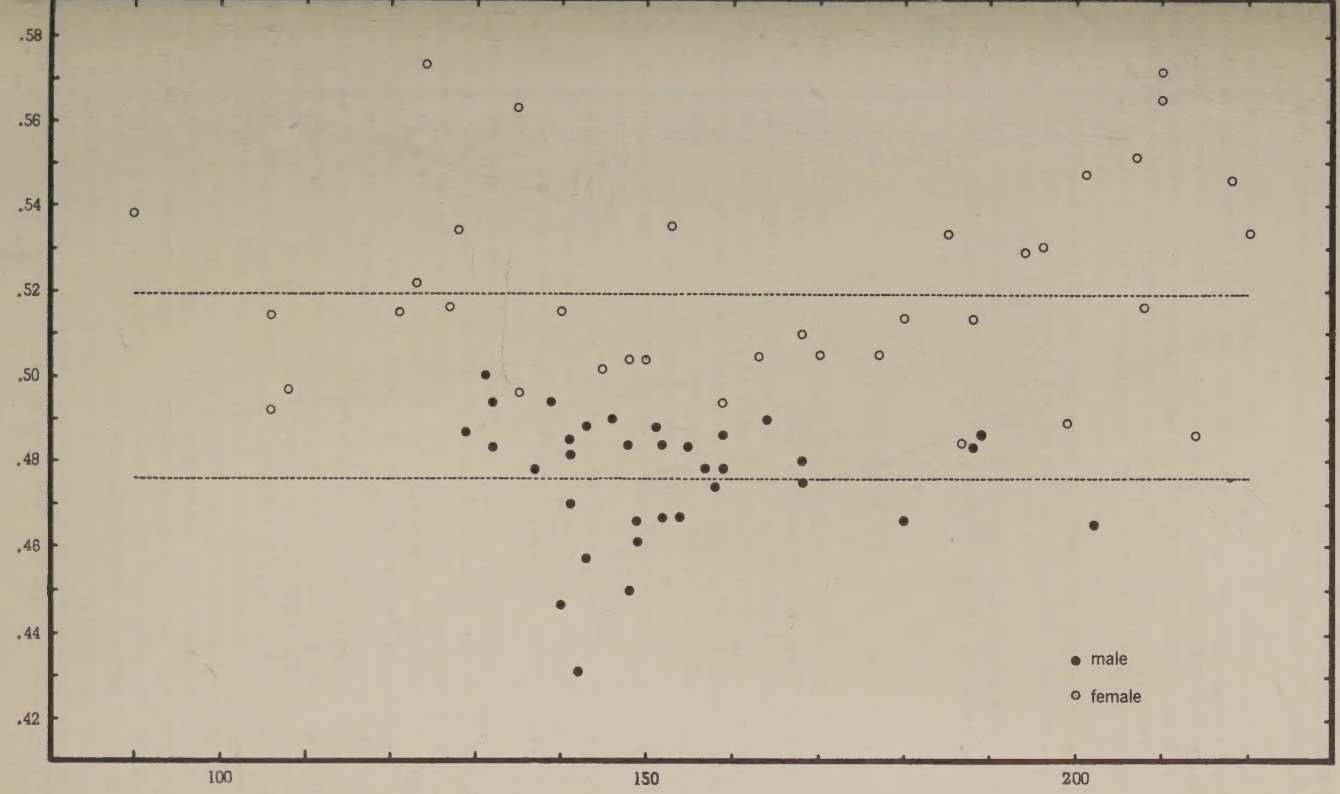


Fig. 1. Tail-in-trunk values (vertical scale) graphed against standard length in mm. (horizontal scale). Mean value for females (.519) indicated by upper dotted line and for males (.476) by lower dotted line.

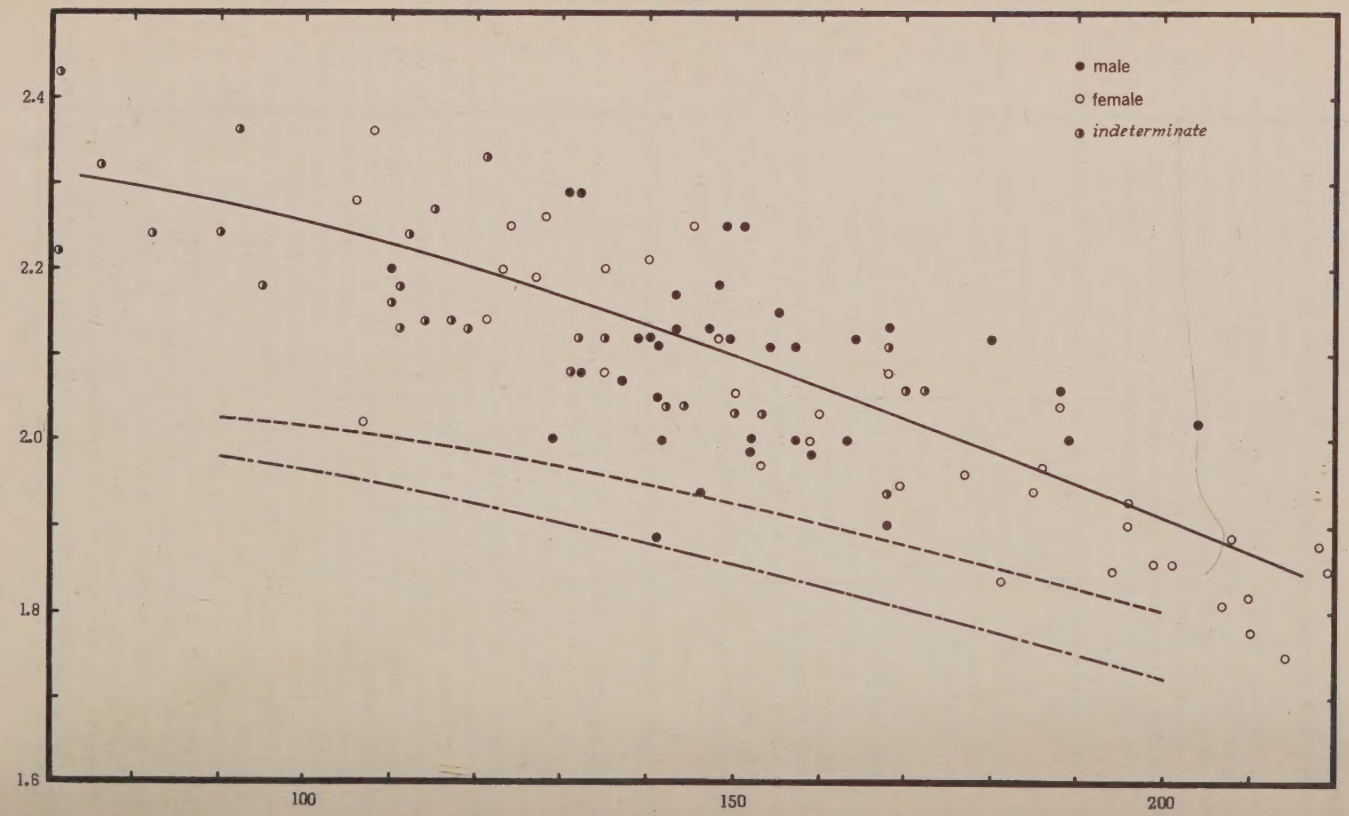


Fig. 2. Snout-in-head values (vertical scale) graphed against standard length in mm. (horizontal scale). Trend lines fitted by eye. *S. c. leptorhynchus*, 97 specimens (———); approximate trend for *S. c. griseo-lineatus*, 20 specimens (- - - - -); and approximate trend for *S. c. californiensis*, 20 specimens (— · —).

nges in head and snout with growth of the individual, but he did not give meas-ments of the growth changes. Ginsburg (1937) has pointed out these changes in seahorses.

Head-in-standard-length when graphed against the standard length (Fig. 3) es a curve which shows that, as contrasted with the condition found in many er fishes, the head in relation to the rest of the body grows proportionately ger. This, as previously shown, is due to the rapid increase in the length of snout. When head-in-standard-length values of females are compared with those males (Fig. 3, Fig. 4), it is apparent that some factor present only in the es has caused the increase in head size in relation to standard length to be s rapid with growth than is the case with the females. This factor, of course, be none other than the increased length of the individual segments of the tail g. 1), which is probably due to the brood pouch.

The proportional change in the size of the eye with growth was not studied, the impression gained was that there is little relative change in this struc-e.

THE BROOD POUCH

The first external indication in ontogeny of the formation of the brood ch in *Syngnathus californiensis* is a darkened area on the ventral surface of the l; it lies in the center, the width being about one-half that of the tail and length being nearly that of the future brood pouch, that is, between 17 to 25 gs (Fig. 5). As development proceeds, this darkened area becomes concave (Fig. lateral flaps make their appearance, and the pouch primordium increases its ume by invagination laterally beneath the flaps (Fig. 7). As the time approaches n the empty-pouched male becomes receptive for eggs, the pouch flaps no longer flat on the ventral tail surface, but become semi-turgid, more vascular, and e on a puffy appearance (Fig. 8). This dilated condition of the pouch flaps is oubtedly an aid to the male in working the eggs posteriorly in the pouch.

Oviposition has been described by Gudger (1905) and consists of "the fishes ertwining their bodies like two capital letter S's, the one reversed on the er, thus bringing them face to face (Fig. 10). Thus they hold their bodies ether while the eggs pass from the oviduct into the pouch. Their bodies touch three places—in the anterior region, just back of the pectorals; in the pos-ior region at a point about two-thirds of the way from the anus to the caudal; at the anal openings. The anal papilla, or the protruding oviduct of the fe-e, is, at the moment of contact of their bodies, thrust into the buttonhole-ped opening at the anterior end of the marsupium. Some eggs, in number a dozen more, now pass into the pouch and are presumably fertilized at this moment."

Each batch of eggs must be worked toward the posterior end of the pouch be-e the male is able to receive more. Indications that the deposition of eggs may e place during one or more days are found upon examination of the contents of e pouches; it is at once apparent that there are different developmental stages the eggs of different portions of the pouch, those most caudad being best devel-d and those most cephalad least developed. But when all of the eggs are depos-d in the pouch at nearly the same time, it follows that different developmental ges will not be present. A male of 160 mm. length from Hood Canal, Washington, newly deposited eggs in the pouch which was sealed externally throughout its gth, with the exception of the most posterior part where the flaps were open. ide this open section were five young pipefish, 16 mm. in length and with the

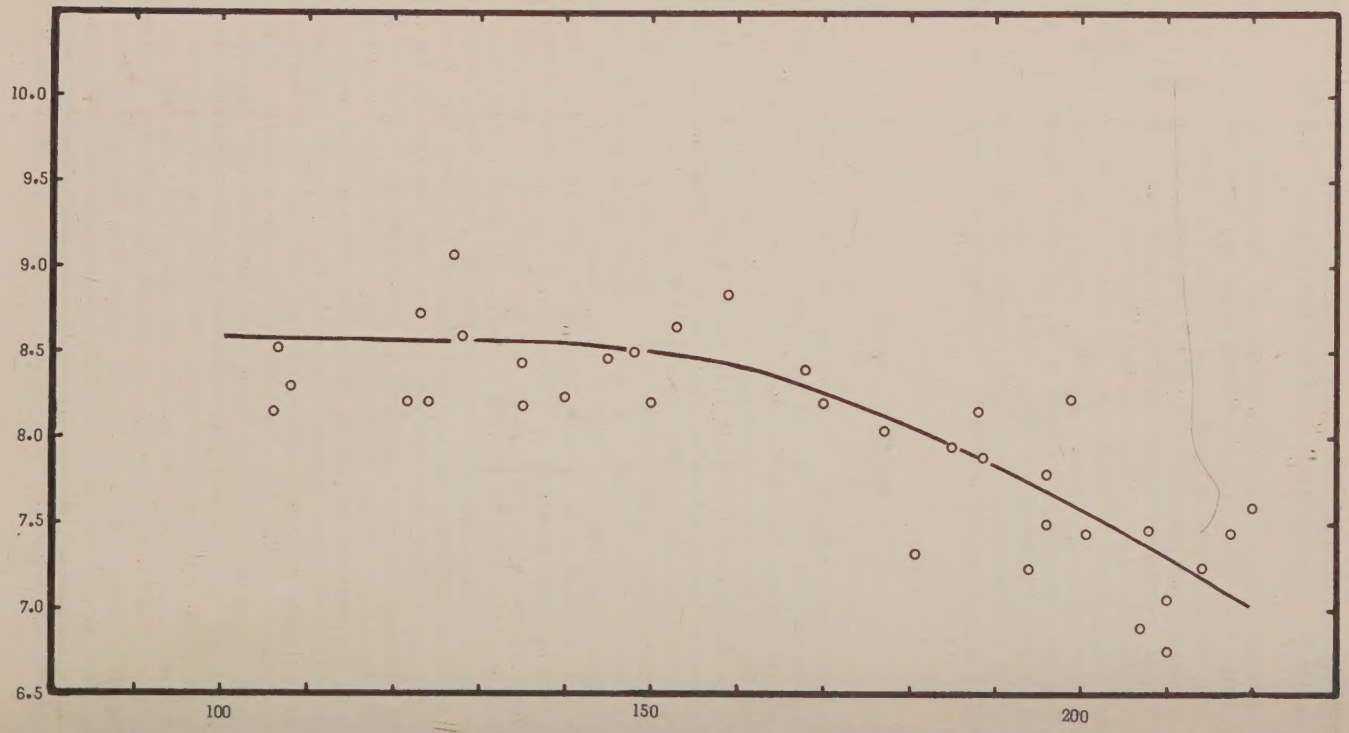


Fig. 3. Head-in-standard length values (vertical scale) graphed against standard length in mm. (horizontal scale); females only. Curve fitted by eye.

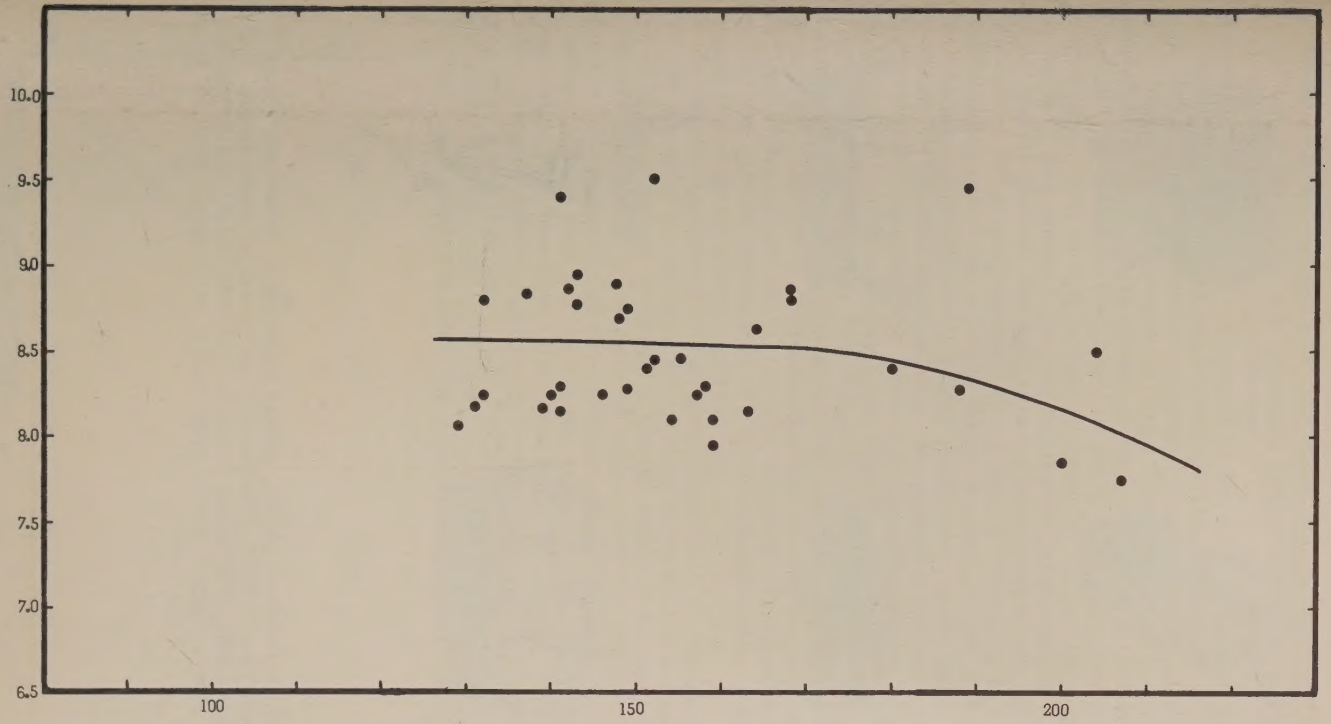
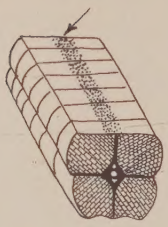


Fig. 4. Head-in-standard length values (vertical scale) graphed against standard length in mm. (horizontal scale); males only. Curve fitted by eye.



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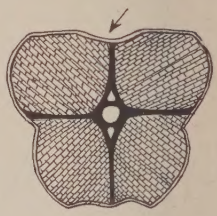

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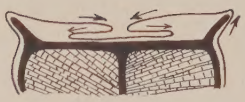

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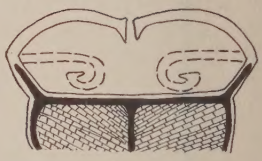

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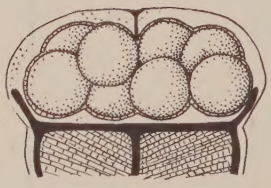

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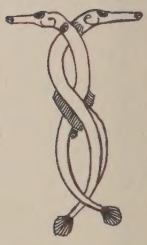

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Fig. 5. Ventral surface of tail showing darkening of future pouch area. Fig. 6 Primary indentation. Fig. 7. Invagination and growth of pouch flaps. Fig. 8. Ma ture pouch with flaps in brooding condition (unbroken line) and in resting condi tion (broken line). Fig. 9. Brood pouch filled with eggs. Fig. 10. Oviposition after Gudger.

sac absorbed. It is probable that these five young represented a previous in-lete filling of the pouch, this structure having been filled again before the ier eggs had completed their incubation.

Soon after the eggs have been placed in the pouch the flaps become tightly essed where they meet in the ventral median line. They appear to be glued to-er with the aid of a mucilaginous substance. Vascular tissue grows inward from sides of the pouch and surrounds the eggs, thus forming part of the embryonic ranes; this tissue also fills in most parts of the pouch not occupied by eggs. n when a male is in a non-reproductive state, the pouch cavity will extend the most caudal part of the ventral opening for one or two rings, but this male may have this posterior portion filled with spongy vascular tissue during breeding season, provided the eggs have not been crowded back into this part.

There is no definite arrangement of the eggs in the pouch; they are usually but occasionally one or three layers deep and usually three or four layers in h. The pouch does not increase in length to any great extent during the life of fish, two or three rings perhaps being the maximum increase in this species.

For *S. floridae* Gudger (1905) gives the incubation period as eight to ten from the time of deposition until the time of emergence; the extent of the ding season is not known. For individuals from Point Mugu it is fairly certain the breeding season extends throughout the year with less reproduction during winter months of November, December and January. Collections are available this locality for every month with the exception of August and September, since July and October were months of high reproductive rate, the probability the former two being the same is quite strong.

If the reproductive season is year-around, and eight to fifteen days are re-ed for the emergence of the young from the pouch, it will be necessary to know number of young contained in the pouch and the number of broods per adult male rder to make any kind of an estimate as to the number of offspring from a sin-brood pouch per season. For this purpose twenty males of the subspecies, *eo-lineatus*, ranging from 100 to 200 mm. and with full or nearly full brood hes were chosen; all were from Holly, Hood Canal, Washington. Eggs and embryos carefully removed from the pouches and counted with the following results: mm. standard length (144 eggs), 111 (123), 114 (160), 117 (100), 121 (180), (103), 126 (140), 130 (288), 136 (255), 139 (169), 139 (236), 142 (315), 150), 151 (317), 154 (250), 158 (400), 163 (443), 174 (474), 175 (478), 187 (354), (602).

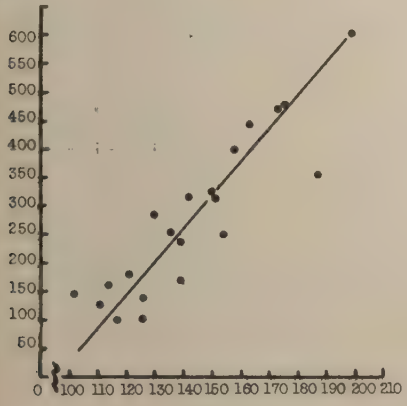

Fig. 11. Ratio of number of eggs in brood pouch (vertical scale) to standard length in mm. (horizontal scale).

It will be noted in Fig. 11 that the trend is linear, being expressed y = 5.70x − 532, or in other words, the number of eggs in any given brood pouch equal to 5.70 times the standard length of the fish, minus 532.

Since males are found with filled pouches throughout most of the year, t broods per year is probably a conservative estimate. Taking the average length of male at 160 mm. and the number of eggs for that length as approximately 380, t result would be 3,800 offspring per year for a fish of this length.

The proportion of adult males to adult females in any population should al be taken into account. Usually the ratio varies between 1:3 to 1:8. Only in one i stance was this not the case; specimens from Hood Canal, Washington, had a ratio approximately 1:1.

Two males of the kelp pipefish (*S. c. californiensis*) from Monterey Bay, 3 and 355 mm. in length, had 390 and 590 eggs respectively. In each, the eggs measur two mm. in diameter. When the numbers of eggs from these pouches are compared wi the number taken from the pouches of the bay form, it is immediately noted, tha on the basis of size of the adult fish, these individuals should have one-ha again as many eggs. The explanation is to be found in the diameter of the egg; the large kelp pipefish it is 2 mm., whereas in the bay form it is 1-1.5 mm. Of t other kelp pipefishes available for examination, six were brooding males under 3 mm.; all of these had normal sized eggs about 1 mm. in diameter. This would indica that there was an increase in the size of the egg with an increase in the length the ovipositing female. This phenomenon is known to occur in some of the Salmonid and is common knowledge in hatchery practice.

In the males from Point Mugu there are apparently two different develo mental rates; in most cases the groove of the brood pouch first appears in spec mens 110 to 140 mm. in length, but there is another group, of 160 to 180 mm., which the pouch is just beginning to appear.

The difference in males and females in body length at the time when th attain sexual maturity is pronounced in the Point Mugu specimens; 90 mm. femal were found in which the ovaries were distended with eggs, but on the other hand the males did not begin to show signs of the brood pouch until they reached length of 110 mm., and they usually were not ready for reception of the eggs unt they were 125 to 135 mm. Gudger (1905) found similar differences while working *S. floridae*, the youngest egg-bearing males appearing at 115 mm. and the younge egg-bearing females at 75 mm. Comparison of egg-bearing individuals of *S. florid* and *S. c. leptorhynchus* is presented in Table 3.

Table 3. Range in size of egg-bearing individuals of *S. floridae* and *S. leptorhynchus*.

	Male	Female
Syngnathus floridae, Beaufort, N.C.	115-227 mm.	75-205 mm
Syngnathus c. leptorhynchus, Pt. Mugu, Calif.	110-204 mm.	91-220 mm

Gudger says, as a result of his observations, that it may be necessary f the male and the female to be nearly of the same size for coition to take place; h cites an instance where a ripe female paired with a male three-fifths her si dropped her eggs in the water. If this hypothesis is correct, then a large numb of the females shorter than the length at which the male is able to receive t eggs (125 to 135 mm.) must necessarily find no suitable pouch for the deposition the eggs.

KEY TO WEST AMERICAN SYNGNATHUS NORTH OF MEXICO[1]

Trunk rings 14, 15 or 16.
Dorsal rays 20-23; head-in-standard length 10-12.3; brood pouch covering 20-23 tail rings. (San Pedro and Santa Catalina Id., Calif., to Mazatlan, Mex.; one specimen taken at Tomales Bay, Calif., pelagic and in eelgrass beds of shallow bays and sloughs.).....*S. arctus.*
Dorsal rays 26-34; head-in-standard length 7.0-10.5; brood pouch covering 17-19 tail rings. (Anaheim Bay, Orange County, Calif., to Mazatlan, Mex.; in eelgrass beds.).....*S. auliscus.*
Trunk rings 17 or more.
Dorsal rays 28-37; (7 of 220 specimens with 37 rays, 3.18 per cent; 26 of 220 with 36 rays, 11.8 per cent); rings 17-19 plus 36-42. (Morro Bay, Calif., to Punta Banda Estero, near Ensenada, Lower Calif.; in eelgrass beds.) .....*S. c. leptorhynchus.*
Dorsal rays 35-47; (23 of 466 specimens with 35 rays, 4.92 per cent.).
. Tail rings 39-46; (9 of 338 specimens with 46 rings, 2.66 per cent); body rings 18-20; dorsal rays 35-44. (Elkhorn Slough, Monterey Bay, Calif., to Sitka, Alaska; eelgrass beds.).....*S. c. griseo-lineatus.*
. Tail rings 45-50, mostly 46 and greater; body rings 18-21; dorsal rays 36-47. (San Francisco and Monterey Bay regions where it intergrades with the *griseo-lineatus-leptorhynchus* complex, to Ballenas Bay, Lower Calif.; in kelp beds, very rarely coming into bays.....*S. c. californiensis.*

SYSTEMATIC ACCOUNT

Genus *Syngnathus* Linnaeus

gnathus Linnaeus, 1758, p. 336 (genotype by subsequent designation of Int. Comm. Zool. Nom., Opinions 45 and 77, *Syngnathus acus* Linnaeus).
hostoma Rafinesque, 1810, p. 18 (genotype by monotypy, *Siphostoma pelagicus* Linnaeus).
honostoma Kaup, 1856, p. 48 (emendation).
matostethus Gill, 1863, p. 283 (genotype by monotypy, *Dermatostethus punctipinnis* Gill).
ictes Jordan and Evermann, 1927, p. 504 (genotype by original designation, *Syngnathus fuscus* (Storer).

DIAGNOSIS.—Body slender, elongate, with an exoskeleton composed of plates anged hexagonally or tetragonally on the trunk and tetragonally on the slender l. Plates or shields often transversely striated. Head slender, tapering into tube-like snout; the latter often keeled. Operculum striated longitudinally, ally with a central keel, complete or restricted to basal part of operculum. erior cristae of trunk and tail discontinuous; inferior cristae of trunk and l continuous; median cristae of trunk subcontinuous with superior cristae of l. All fins membranous; usual range of number of rays: D. 20-45, A. 2-4, P. 10-C. 10; ventrals absent. Eggs incubated in a brood pouch formed by fleshy folds

[1] For key and checklist of other west American pipefishes, see Herald, 1940.

arising latero-ventrally beneath tail, beginning immediately posterior to anus a extending caudally 14-25 rings; some species with vestigial bony plates wit folds.

RANGE.—World wide in temperate and tropical seas; some species adapte fresh- and brackish-water habitats.

Syngnathus californiensis californiensis Storer

Kelp Pipefish

Syngnathus californiensis Storer, 1848, p. 73 (California).
Dermatostethus punctipinnis Gill, 1863, p. 283 (San Diego, California).
Siphostoma exile Osburn and Nichols, 1916, p. 153, fig. 7 (Port San Bartolom Lower California).

SYNONYMY.—Since Duncker (1915) recognized *Dermatostethus* as a synonym *Syngnathus*, but did not discuss *S. californiensis*, *griseo-lineatus* and *leptorhy chus*, it should be stated why *punctipinnis* is to be considered a synonym of *cal forniensis*. Four specimens were mentioned in the original description of *pun tipinnis*; they were all from San Diego, California, and were said to be "about inches long." Rings were 19 plus 39 and the dorsal count was 41. San Diego *lept rhynchus* have a maximum length of 10 inches, maximum ring count of 18 plus 40 a maximum ray number of 35. Hence the types of *punctipinnis* must have been specime of the kelp subspecies, *S. c. californiensis*.

I have placed *S. exile* as a synonym of *S. c. californiensis*. The four par types of *exile* were kindly forwarded to me for examination by Mr. Nichols of t American Museum; in addition Dr. Leonard Schultz of the National Museum very gra ciously examined the type of *exile* (USNM 87543). From this data I find the fi specimens to be typical Lower California representatives of the subspecies *cal forniensis*. The decided bulge in the posterior part of the abdomen, mentioned the original description of *exile*, is a characteristic of all three subspecies It is most pronounced in the females and is usually due to the pressure of th gonads against the body wall. Apparently the walls do not subside appreciabl even when the individual is not in a reproductive state.

TYPES.—Not designated in original description and probably lost; type spec imen collected on "the western coast of California by Captain Phelps"; date no recorded. Type of *punctipinnis* apparently not extant. Type of *exile*, USNM 87543.

DIAGNOSIS.—D. 36-47; A. 3; P. 12-14, usually 13-14; C. 10; trunk rings 18 21, occasionally 17 or 22 at southern and northern extremes of range, respectively tail rings 45-50; body much elongated; one of the largest pipefishes known, wi lengths up to 450 mm.; most common lengths up to 380 mm. Snout longer in relation head in larger specimens, hence snout-in-head and head-in-standard length measure ments vary according to length and sex of fish, latter being due to longer tails males. Snout very slightly keeled, if at all. Opercle striate longitudinally nearly always without carination, its contour from dorsal or ventral view qui variable. Body angles smooth; trunk nearly same girth throughout length in youn specimens and males; large females often with pronounced bulge in posterior po tions of trunk. Rings composed of plates, transversely striated. Keel system typ ical of *Syngnathus*.

Dorsal covering $\frac{1}{2}$-$1\frac{1}{2}$ plus $7\frac{1}{2}$-9 rings depending upon number of rays in fi 4-5 rays per segment, occasionally 6 on last segment. Brood pouch covering 19-2

s, number of rings covered increases slightly with size and experience of male. rently eggs increase in diameter with increase in length of ovipositing female, e number of eggs carried in pouch of large males decidedly fewer than number ied by large males of bay subspecies.

Greens and browns predominant, the former probably more common; shade and r dependent upon environment. One small, brown specimen from Santa Rosa Island white ring every 4 or 5 rings; white mottling occasionally present in other imens from the islands.

RANGE AND HABITAT.—Region of San Francisco and Monterey Bays, where sub- ies intergrades with eelgrass form, *griseo-lineatus*, south to Ballenas Bay, r California; may range farther south, but doubtfully farther north; usually d among kelp, rarely entering bays except at intergradational points. (Of the specimens which I have examined from Point Mugu Lagoon, Ventura County, Cali- ia, the results of 18 collections over a year's time, only one specimen was a pipefish.)

COMPARISONS.—The kelp subspecies may be differentiated at all times from *orhynchus* by the higher meristic counts (ring and dorsal fin), the habitat *torhynchus* occurs only in eelgrass found in bays), and the size of adult spec- s (*leptorhynchus* reaches a length of 240 mm. and *californiensis*, 430 mm.). As iously shown, the snout of the kelp pipefish is longer when compared with bay fish of equal size; in addition the latter are more robust when compared with a form of equal size. *Californiensis* and *leptorhynchus* have nearly the same h-and-south range. The *leptorhynchus*-like form north of Monterey Bay is *griseo- atus*; this last form overlaps the range of *californiensis* only in the San Fran- o and Monterey Bay regions.

Californiensis and *griseo-lineatus* may be differentiated on the basis of l ring counts, no specimen of the latter having a higher count than 46, with the lest mean 44, whereas the former ranges from 45-50, most counts being 46 and ater.

DISCUSSION.—Because the chief habitat of *californiensis* is in kelp beds, ividuals of this subspecies are collected only sporadically, and usually by ident. However with a total of 128 specimens from a large number of localities, was possible to study the subspecies in detail.

The first question which must be answered is why *californiensis* should be sidered a subspecies of the *leptorhynchus-griseo-lineatus* complex. I base my tention that it belongs to this complex chiefly upon the overlapping of dorsal , body, and tail ring counts of specimens from the following three areas: Morro , the northern extremity of range of *leptorhynchus*; Elkhorn Slough, Monterey , the southern extremity of range of *griseo-lineatus*; and the open waters of terey and San Francisco Bays combined, the approximate northern extremity of ge of *californiensis*. The overlapping of dorsal fin and tail ring counts is wn in Table 4.

My contention is further based upon the fact that the Elkhorn Slough fishes larger than those from any of the sloughs to the north or to the south; this reased size is thought to be a result of interbreeding with the larger kelp efish. To be explicit, for the 797 specimens from the five localities within the ge of *leptorhynchus*, there are no specimens over 240 mm. in length; California cimens of *griseo-lineatus* (other than from Elkhorn Slough) do not grow longer n 250 mm., although an increase in length is found with a decrease in latitude. ree specimens from Sitka, Alaska, measure 268, 278 and 314 mm.) But when a ies of individuals from Elkhorn Slough was examined, it was found that 10 of 59 e longer than 250 mm., the longest being 311 mm.

Why should a kelp-inhabiting pipefish enter Elkhorn Slough and not other

Table 4. Dorsal fin ray and tail ring counts for *S. c. californiensis* intergradational areas.

DORSAL FIN RAYS	Morro Bay	Elkhorn Slough	Monterey and S. F. Bays (open water)
30	1		
31	3		
32	1		
33	4		
34	7		
35	5	2	
36	4	4	
37	1	9	
38		9	
39		15	1
40		11	0
41		6	4
42		3	2
43			4
44			2
45			3
46			3
47			1

TAIL RINGS	Morro Bay	Elkhorn Slough	Monterey and S. F. Bays (open water)
36	1		
37	3		
38	6		
39	12		
40	3	7	
41	1	8	
42		14	
43		17	
44		9	1
45		3	1
46		1	2
47			7
48			4
49			3
50			2

similar estuaries along the coast? Some explanation for this may be obtained i the position of kelp beds and currents in Monterey Bay are studied. The only ke beds are at the northern and southern ends of the bay, at Soquel Point and Pacif Grove, respectively; these points are over 20 miles apart (Cameron, 1914). Skog berg (1936), in a report on the hydrography of the bay, finds that the surfa currents near Pacific Grove, although they may for a time be directed seawar nearly always reverse and flow in toward the bay, along the shore. Unfortunate for our purpose, these investigations are not completed so that final determin tions of the extent of this shore current, or of other currents within the bay a impossible. It does seem well within the realm of possibility that pipefish wa out of the kelp beds at either end of the bay might be carried by the currents the vicinity of the entrance to the slough, and with the change of tide be carri into the lagoon. There are no kelp beds along this part of the shore in which th fish might find refuge. Once in the slough, interbreeding with the bay form sho result.

At the present time I am not prepared to offer a logical explanation as t why *californiensis* does not occur to the north of the San Francisco Bay regio The kelp beds beyond this point are thinner, smaller and farther apart than thos to the south, but this should not affect this semi-pelagic kelp pipefish.

Upon comparing specimens from the northern and southern extremes of th range, 20 individuals from San Francisco and Monterey Bays as against 10 indivi uals from San Quintín, San Bartolomé and Ballenas Bays, Lower California, so differences are apparent as shown by Table 5.

It is evident from this compilation that the principal change in the sub species from one extreme of the range to the other is in the length of the speci mens and in the number of trunk rings. The number of tail rings and to a lesse

Table 5. Comparison of northern and southern groups of *S. c. californiensis*

	Northern Group	Southern Group
ber of Specimens	20	10
imum Size	430 mm.	200 mm.
nk Rings	19-22	17-19
l Rings	44-50	45-50
sal Fin Rays	39-47	37-44
toral Fin Rays	13-14	12-13

ent the number of dorsal fin rays remain relatively constant. Specimens from the lowing localities were available for the study of this subspecies: San Fran-co-Monterey, 20; Morro Bay, 14; Santa Barbara, 16; San Pedro-Long Beach, 18; ta Catalina Island, 12; Santa Rosa Island, 2; Santa Cruz Island, 9; San Nicolas and, 1; San Diego, 22; Ensenada, 4; San Quintín Bay, 2; Port San Bartolomé, 7; lenas Bay, 1; (last four localities are in Lower California). No pipefishes are wn from Guadalupe, San Clemente, Santa Barbara, San Miguel and Anacapa Islands, since all of these islands have heavy beds of kelp (Cameron, 1914), it is prob-e that the subspecies will be collected there in the future.

Syngnathus californiensis griseo-lineatus Ayres

Northern Bay Pipefish

gnathus griseo-lineatus Ayres, 1854, p. 14 (San Francisco Bay).
gnathus abboti Girard, 1859, p. 346 (San Francisco).
gnathus arundinaceus Girard, 1859, p. 346 (Coast of California).

SYNONYMY.—In 1898 Jordan and Evermann listed *arundinaceus* as a synonym of *torhynchus*. In 1928, Jordan, Evermann and Clark entered it as a valid species, did not give their reasons. With a dorsal fin count of 35, the type specimen on ch the description of *arundinaceus* was based might have been either *griseo-eatus* or *leptorhynchus*, but the ring count of 19 plus 43 precludes its being thing other than *griseo-lineatus*. In the original description the locality was en as "Coast of California." From the ring and dorsal fin counts, it is very bable that the type of *arundinaceus* came from the San Francisco Bay region. *oti*, the other synonym of *griseo-lineatus*, was also described by Girard, and on same page in the same publication. Its type locality was given as "San Francis-" There is no question about *abboti* being a synonym of *griseo-lineatus*.

TYPES.—Number 835, Acad. Nat. Sci. Phila., as reported to me by Mr. Henry Fowler; collector and date of collection not recorded. Type of *abboti*, USNM 971. e of *arundinaceus*, USNM 972.

DIAGNOSIS.—Similar to *californiensis* in most details; adults smaller, 250 in the San Francisco region, increasing northward to about 315 mm. at Sitka, ska; more rotund in trunk area (especially true of females from Puget Sound); o differs in snout-head relationships, snout being shorter when compared with a p specimen of equal size. D. 35-44; rings 18-20 plus 39-46; P. 11-13.

RANGE AND HABITAT.—From San Francisco and Monterey Bay regions, where it ergrades with *californiensis*, north to Sitka, Alaska; may range into Bristol

Bay, Alaska; found usually in eelgrass of shallow and somewhat sandy bays; pra tically never pelagic.

COMPARISONS.—For comparison with *californiensis* see preceding subspecie average tail ring count for *leptorhynchus* below 41; *griseo-lineatus* above 41; ave age dorsal fin count of former below 35; latter above 36; dorsal fin count of fo mer, 28-37; of latter, 35-44.

DISCUSSION.—It will be noted from the graphs (Fig. 10) that *griseo-lineat* is more homogeneous in regard to meristic characters than is *leptorhynchus*, w perhaps the exception of specimens from Puget Sound, where there is a decided d in the meristic counts. This is undoubtedly a temperature effect, with the cold coastal waters of Grays Harbor, Washington, naturally resulting in higher coun than the warmer inland waters of Puget Sound. To find out whether there was a sig nificant difference between the specimens from the last two localities, a series o 49 was studied from the former and 40 from the latter (Hood Canal). The dorsal fi counts were tested statistically by means of the *t* test (following Snedecor's meth ods); this gave a value of 1.2, which for the 87 degrees of freedom is not sig nificant. In other words, a difference of three rays between the mean ray coun (40.4 and 37.1 for the two adjacent localities) is within the range of norma chance expectancy.

In order to find out something about the homogeneity within a larger part o the subspecies, a section from Elkhorn Slough to Grays Harbor, inclusive, was cho sen, and analysis of variance applied to the dorsal fin values of the 11 popu lations within the area. An *F* value of 10.637 was obtained, which for 275 and 1 degrees of freedom is very significant with a probability of chance occurrence o less than 1 in 100, that is to say, the group is not homogeneous. A significan part of the variance lies not within the groups but between the groups.

Statistically, *griseo-lineatus* is shown to be different from *leptorhynch* in respect of dorsal fin ray count. By application of the *t* test to all of th available specimens in each of the two races a value of 5.1 results. For the degrees of freedom this value has a probability of occurrence of less than 1 in 100.

For a study of this subspecies, 759 specimens were available, mainly from localities. Average fin and ring counts together with the respective localit ranges are presented graphically in Fig. 12; (for complete data from which the graphs are made, see Herald, 1939 M.A. thesis on file at Univ. of California Berkeley). Additional localities not included upon the graphs were San Lorenzo River, Monterey Bay, California, 3 specimens; Nestucca Bay, Oregon, 2; Columbia River, Oregon, 1; Ucluelet, B.C., 1; Departure Bay, B.C., 1; Gabriola Island, B.C., 1; Kilisut Harbor, Puget Sound, Washington, 3; Yes Bay, Alaska, 1; Johnson's Cove, South Wrangell Island, Alaska, 1. None of these ungraphed specimens deviates markedly from the mean values of adjacent populations.

Syngnathus californiensis leptorhynchus Girard

Southern Bay Pipefish

Syngnathus brevirostris (nec *S. brevirostris* Rüppell 1840) Girard, 1856, p. 156 (San Diego, California).
Syngnathus leptorhynchus Girard, 1856, p. 156 (San Diego, California).
Syngnathus dimidiatus Gill, 1863, p. 284 (San Diego, California).
Siphostoma barbarae Swain, 1884, p. 238 (Santa Barbara, California).

SYNONYMY.—I have followed Hubbs (1916) in placing *barbarae* as a synonym of *orhynchus*. Dr. L. P. Schultz of the National Museum has kindly rechecked the e specimen of the former (USNM 31253), and he finds it to have seven rays in the al fin; this would indicate regeneration (Duncker, 1905). From the measurements counts, *barbarae* is of the *leptorhynchus* group, which means that it is a bay n. At the present time at Santa Barbara, where the type of *barbarae* was col- ted, there is no suitable habitat for eelgrass forms. Goleta Bay, ten miles to north of the city, is without eelgrass. The diked lagoons within the city its may previously have been open to the sea and possibly were suitable for efishes. However, it must be pointed out that if *barbarae* were a normal speci- , it certainly was closely related to, or may have been the same as, *Syngnathus rdianus* of Dumeril (1870, p. 574), which is known only from the type specimens en in 1867, the locality given as "Mexique, près de la Californie." In fact, in first reported the type of *barbarae* as *bairdianus*. Through later communica- n with M. Thominot of the Paris Museum, he was told that the dorsal fin of *rdianus* covered 3 plus 5½ rings. Because of this difference *S. barbarae* was cribed. But Thominot was in error, for the dorsal fin covers 2 plus 6 rings. I rn this from Dr. Paul Chaubanaud of the Paris Museum, who has kindly reexamined types. Incidentally, with the holotype of this species there is also a para- e; this has never been mentioned in any of the literature, nor have measurements n given; suffice it to say, it differs only slightly from the holotype. A com- te discussion concerning *bairdianus* will be given in a forthcoming paper on the efishes of the Americas.

TYPES.—Type of *leptorhynchus* was USNM 670, collected at San Diego by A. sidy in 1853. It is not mentioned in a list of Syngnathid types in the USNM plied to me by Dr. L. P. Schultz. Type of *brevirostris*, USNM 969, still extant. e of *dimidiatus* apparently not extant. Type of *barbarae*, USNM 31253, discussed ove.

DIAGNOSIS.—Similar in most details to *griseo-lineatus*; differs in being rter, the longest adult specimen, a male, 240 mm. from Anaheim Bay; usual size of ge adults, 200-210 mm.; (*griseo-lineatus* adults to 315 mm.); dorsal fin range, -37; rings 17-19 plus 36-42.

RANGE.—Known range from Punta Banda Lagoon, Ensenada, Lower California, rth to Morro Bay, San Luis Obispo County, California; range probably extends h farther south. Eelgrass said to extend south on peninsula only to Magdalena y; hence this point should be limit of southern range of *leptorhynchus*, an eel- ass-inhabiting form.

COMPARISON.—See previous comparisons under *californiensis* and *griseo- neatus*.

DISCUSSION.—From the graphs (Fig. 12) a tabulation has been compiled (Table to show the amount of differentiation in relation to the distance between local- ies. From this compilation it is apparent that the differences between the five pulations are due to some other factor than the distance between localities, and is believed that temperature is responsible for this effect. Additional evidence pporting this contention is found when Grays Harbor and Puget Sound localities r *griseo-lineatus* are studied, for here the differences in meristic counts must rtainly be due to differences in temperature.

Analysis of variance was applied to the mean values of the dorsal fin counts r the different populations with a resultant *F* value of 46.3, which means that ere are considerable and recognizable differences between the different popula- ons when all specimens of *leptorhynchus* are considered as a whole; in other rds, it is not a homogeneous group. This *F* value has a probability of occur-

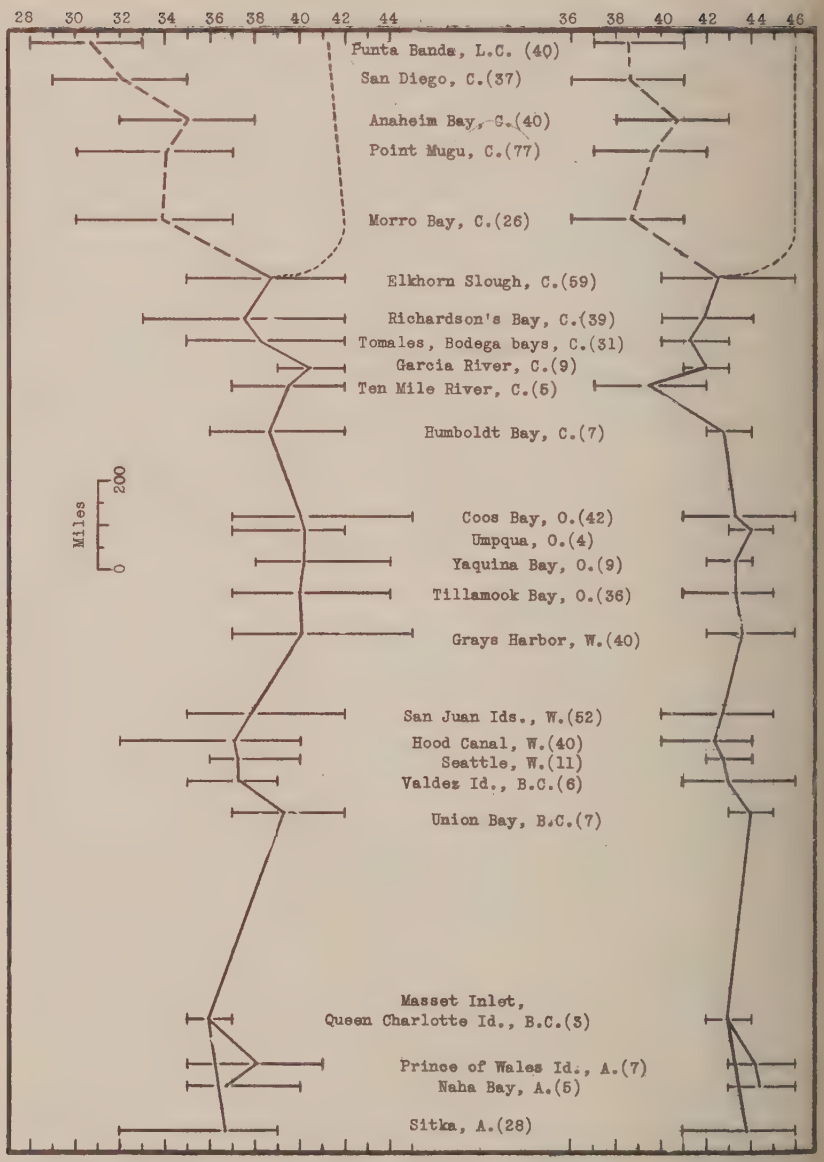

Fig. 12. Graphs of mean counts of dorsal fin rays (left) and tail rings (right). *S. c. Leptorhynchus* (— —); *S. c. griseo-lineatus* (——); and *S. c. californiensis*, estimated (·····). Numbers of specimens used in calculations indicated in parentheses following locality names. Range of counts indicated by horizontal lines through locality means. Localities separated approximately in proportion to intervening coast line distances.

able 6. Differences between means of trunk, tail ring, and dorsal fin ray counts for the five localities of *S. c. leptorhynchus*

Localities	No. of Specimens	Miles Between Localities[1]	Differences Between Means: Trunk Rings	Tail Rings	Dorsal Fin Rays
a Banda, L. C.	40				
		80 →	+.12	+.11	+1.49
Diego Bay, Calif.	37				
		93 →	+.81	+2.02	+2.83
eim Bay, Orange Co., lif.	40				
		64 →	−.14	−.97	−.87
t Mugu Lagoon, Ventura ., Calif.	77				
		155 →	−.33	−1.03	−.29
o Bay, San Luis Obispo ., Calif.	26				

stal or water distance.

e of less than 1 in 100. Between groups difference was equal to 125 and within ps, 2.47; the individual populations themselves are fairly homogeneous, and the e differences lie between the different groups. An *F* value of this significance ld not be unexpected after consideration of Fig. 12; this demonstrates how the s from different localities rise rapidly, when compared with the lesser varia- t from locality to locality found in *griseo-lineatus*. The *F* value of the latter, reviously given, is 10.637, or approximately one-fourth of that for *lepto- chus*. Because of the similarity of the graph for the means of tail ring counts he graph for the dorsal fin counts, analysis of variance was not applied to the er. A highly significant *F* value would have resulted in this case. The d mean for the dorsal fin count of all *leptorhynchus* is 33.15 while that for eo-lineatus is 38.63; tail ring grand means are 39.22 and 42.85, respectively.

I am at a loss to explain the break between subspecies of eelgrass pipe- es in the region between Monterey and Morro Bays. Of course some of the dif- nce is due to interbreeding of kelp and eelgrass forms at Elkhorn Slough, but cannot account for all the difference. If bay temperatures are related to eral coastal temperatures, then currents certainly will be important in deter- ng this factor for any given lagoon or estuary. But a study of the California ents does not provide an explanation for this break between races of eelgrass fish in this section of the coast.

Hubbs (1921) has found that *Leptocottus armatus* shows nearly the same break veen subspecies as that described here for the bay forms of *S. californiensis*. should be pointed out that the young of *Leptocottus* live in bays whereas the lts are usually found along open shores.

Syngnathus californiensis avus Jordan and Gilbert

gnathus avus Jordan and J. Z. Gilbert, 1919, part 2, p. 34-35 (Miocene chalk- shale, near Titus Avenue, Bairdstown, California).[2]

ording to Dr. Curtis J. Hesse of the Texas Agricultural and Mining College, Bairdstown is now led Baird Park and is on the southwest side of Newton Park, just outside of South Pasadena; original specimens were collected in the $SW\frac{1}{4}$ of the $SE\frac{1}{4}$ of section 7S, R12W, toward the head a small north-south canyon arising at the end of Drysdale and Pueblo Avenues, Newton Park; us Avenue is no longer on the map.

TYPES.—Stanford University Cat. Fossil Fishes Number XLIV, holotype (B of original description); 115 (also marked number V), paratype (A of original description); 115A, paratype (C of original description). Material is said to consist of twelve specimens; Jordan later (1926) said there were nine specimens; I have not been able to locate the remaining six or nine paratypes; there are other specimens of this subspecies in the Stanford Natural History Museum, but they are not labeled as types.

DISCUSSION.—Working from the description alone, I should be inclined to place *avus* as a subspecies or even a synonym of *S. c. californiensis*. From the counts and measurements given for *avus* it is evident that the fish is closely related to the open coast and kelp form (*californiensis*) and not to the bay form (*leptorhynchus*), as stated by the authors. Jordan and Gilbert speak of fossil seaweeds being "imprinted in the chalky matrix." If so, this would be additional evidence that *avus* is closer to *californiensis*. (No seaweeds were present with the types.) Upon examining the three types it is readily apparent that the original description is extremely inaccurate, for the types do not show the characters which are claimed by the authors. One would naturally suppose that when a table of counts and measurements is given in a description that the first specimen would be the holotype and the second and third, the paratypes, but here this is not the case for A and C are paratypes and B, the holotype; this fact is not mentioned in the description. Only four or five dorsal rays are visible on the holotype and not 36 as stated; however on paratype No. 115 there are 25 present, although none was listed in the original description. This specimen has apparently been broken since the time of the description, for it now consists of but trunk and tail; I find no evidence of brood pouch, which was said to be present. Since in most genera of pipefishes, including *Syngnathus*, the pouch is composed of fleshy flaps only, it is not often that a fossil record of this structure is preserved. The length of paratype C (115A) was measured in a straight line from the head to the caudal fin (ca. mm.), completely disregarding the fact that the specimen lies in a curved position. Measured on the curve of the body, it is about 160 mm. in length.

Through an error, four plates of Steindachner's 1860 paper on the fossil fishes of Austria were published in Jordan and Gilbert's work and used to illustrate the types of *Aboma antiqua*, *Smithites elegans*, *Sebastavus vertebralis* and *Syngnathus avus*. Duncker (1923) severely criticized the authors for their carelessness. In his reply, Jordan (1926 and 1927) points out that the material became from the Los Angeles Museum where a student had been working on the specimens. Since he did not have the literature easily available, he had photographed some of Steindachner's plates in order to make comparisons with his own material. These photographs were sent along with the fossils to Jordan, but without any indication that they were from Steindachner's paper. Jordan and Gilbert had assumed that they were photographs of the originals which were thought to be in the Los Angeles Museum, and so the illustrations were published.

Dr. Loré David of the Department of Geology, California Institute of Technology, Pasadena, has in her possession a large series of representative fossil pipefishes from various Miocene localities in southern California. From a study of these specimens I have come to the conclusion that these fossils are all *avus*, and as such can be accorded no higher than subspecific rank under *S. californiensis*. There is even doubt that they merit this degree of distinction, for the specimens as a whole are certainly very little different from living specimens. Dr. David will deal with the subspecies in detail in forthcoming work on California fossil fishes.

SUMMARY

1. From a study of 34 males and 35 females of the bay pipefish, *Syngnathus eptorhynchus*, from Point Mugu, Ventura County, California, it is found that: there is no significant difference between males and females as to the number ays in the dorsal fin, the number of rings in the trunk or the number of rings he tail; but (b) the individual tail segments in the male are decidedly longer . those in the female. When the trunk length is divided by the tail length, the age for the males is .476 and that for the females, .519. (c) When head-in-k (graph not shown in text) is graphed against the standard length, no sexual erences are present; (d) when tail-in-trunk is graphed against standard length e is an indication of a slight sexual difference, in that the curve for the s has a small downward trend with increase in standard length; this is as would xpected. (e) These sexual differences are similar to those shown in Figs. 3 and which head-in-standard length is graphed against standard length. Here again, differences are due to the increased length of the individual tail segments of male fish which is in turn due to the presence of the brood pouch. It should be d in Figs. 3 and 4 that the largest individuals have the largest heads proportately. This is exactly the opposite of the condition found in most vertebrates. reason for this is apparent when (f) the snout-in-head relationship is graphed nst the length in millimeters, for the resulting curve shows that the larger imens have longer snouts proportionately. The kelp pipefish, *S. c. californi-s*, shows a comparable curve, but the snouts are longer than those of individ- of corresponding size of the bay form. It is apparent that head-in-standard th should not be used indiscriminately as a character to describe taxonomic s of this species unless the size and sex of the individuals are considered.

2. There is no definite arrangement of eggs in the brood pouch; eggs and yos from twenty pouches of the northern bay pipefish were extracted and counted it was found that a straight line resulted upon graphing, the line being ex-sed as $y = 5.70x - 532$ where y equals the number of eggs in the pouch and x, length of the brooding male. There is an indication that there is an increase ze size of the eggs with an increase in size of the ovipositing female (kelp fish). Different developmental rates are found in the males, and a pronounced erence in males and females in lengths at which they attain sexual maturity.

3. Differences between populations from adjacent localities are not propor-al to the intervening distances. It is thought that temperature is the factor onsible for these differences.

4. Upon comparing the series from each locality for the characters used in study, it is found that all of the living members of the *californiensis* group itute but a single species with the chief intergradational points at Elkhorn h, Monterey Bay, and in the San Francisco Bay region. *Syngnathus avus*, the ne fish from southern California is also a subspecies of this group, although y not even deserve recognition as a distinct subspecies. It is shown that the subspecies of *Syngnathus californiensis* are: *S. c. californiensis*, the kelp ish, ranging from Ballenas Bay, Lower California, north to the San Francisco egion, usually in kelp and very rarely coming into bays or sloughs; *S. c. rhynchus*, the southern bay pipefish, ranging from Ensenada, Lower California to Morro Bay, California, in eelgrass of bays and sloughs; *S. c. griseo-tus*, the northern bay pipefish, ranging from Monterey Bay, California, north to , Alaska, also in eelgrass; and *S. c. avus*, of the Miocene of southern Cali-a.

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EMBRYONIC AND EARLY LARVAL STAGES OF THE COTTID FISH *ORTHONOPIAS TRIACIS* STARKS AND MANN

By Rolf L. Bolin

The work reported in the present paper was carried out several years ago ring systematic investigations on the Cottids of California. I had hoped that could eventually be published together with the results of similar investigaons on a large number of the sculpins of this state. Press of other problems kes such a plan seem impossible of fulfillment in the near future and it apars advisable to present the completed work now.

On March 16, 1929, it was my good fortune to capture a mature male and fele of *Orthonopias triacis* Starks and Mann, 1911. When it was discovered that e female contained ripe eggs, a study of the development of these was initiated once since it was improbable that a similar opportunity would soon present itlf; only six specimens of this rather rare fish had been recorded previously.

The spawning season extends at least from the middle of March until the ddle of April, since eggs were stripped from the single gravid female at inter-

vals from March 18 until April 16. This recorded length of the spawning season will undoubtedly be considerably extended when opportunity for examination of other specimens is afforded. It may be of interest to note in this connection that a female taken on January 20, 1929, had her ovaries filled with immature eggs.

Fertilization was found to be internal although this species does not possess the penis which is characteristic of many related forms. On attempting to strip the female, it was found that she has a protrusile oviduct which was extended under the pressure attendant upon stripping, and which was retracted again as soon as pressure was released. While copulation was not observed, it is probable that the oviduct of the female is extended during this process and retracted when it has been smeared with sperm, fertilization taking place afterward while the eggs are being extruded. Since it proved to be impossible to press milt from the male specimen, it was fortunate that the female had been impregnated prior to the first attempt at stripping. It was found that eggs could be secured a few at a time and at frequent intervals over an extended period, and that development was initiated immediately after removal from the female.

The freshly stripped eggs of *Orthonopias* are spherical in form and rather small for Cottid eggs, measuring 0.86 to 1.0 mm. in diameter. Their specific gravity is slightly greater than that of sea water. The eggs are emitted as a fluid mass but adhere tightly to each other within a few minutes after coming in contact with sea water. The egg membranes become slightly flattened wherever they touch each other but the attachment areas are usually quite small. However, one case was observed where the diameter of the flattened area was about one-fifth of the diameter of the egg, giving the entire egg a profile similar to a capital D rather than a circle. While the eggs adhere tightly to each other, they do not have the property of affixing themselves to foreign materials.

The eggs which were stripped on March 18, 20, and 21 were colorless and fairly transparent. Most of the eggs stripped at later dates showed various tones of pale straw yellow and pinkish brown, a few being colorless, and eggs of various colors occurring in the same batch. This difference between the eggs stripped before March 21 and those stripped after March 25, is only one of a series of striking differences observed; differences which will be noted as the discussion proceeds. It is impossible to state whether the eggs from the early strippings or those from the later ones developed in the typical manner, since perfectly normal and healthy larvae resulted from eggs of every group.

The egg membrane is thick, horny, and unsculptured. The micropyle is large enough to be seen under relatively low magnification and appears as a small cone-like depression in the egg membrane. Within the yolk there is an opaque, grayish-brown mass of flocculent material, irregular in shape, which appears as a small white spot when the egg is examined with the naked eye. A large oil globule and sometimes one or two small ones lie imbedded in the yolk near the periphery, while a large number of small globules are scattered over the surface of the yolk (fig. 1).

At the time of stripping, the bulk of the protoplasm is distributed in a layer of uniform thickness over the surface of the yolk. Within five minutes it begins to concentrate at one pole. This concentration is accomplished by a flowage of the protoplasm toward one point, but since the protoplasmic granulations are too fine to permit observation of the streaming movements described by Ryder (1884), Wilson (1891), and others in the eggs of various teleosts, this redistribution appears merely as a local growth of the protoplasm accompanied by a slight shrinkage of the entire yolk sphere and the consequent development of the perivitelline space.

At about three and one-half hours after stripping, the blastodisc is fully eveloped and appears as a rounded symmetrical cap, thick at the center and grad-ally fading into the extremely thin layer of protoplasm investing the rest of ne yolk (fig. 2). During the process of protoplasmic concentration, the yolk ecomes flattened under the blastodisc. At this stage a peculiarity occurred in he eggs of late strippings. The flattened portion of the yolk under the blasto-isc was distorted by a number of prominent and irregular waves, instead of re-aining smooth as in most teleostean eggs.

It may be noted at this time that no protoplasm can be detected within the olk sphere during the early stages, but there is a small amount present which ater on concentrates to form a cap covering about one-third of the surface of he oil globule (figs. 20-22, especially distinct in fig. 21).

The first cleavage occurs about four or four and one-half hours after tripping. The subsequent ones take place at about hourly intervals thereafter. he first cleavage plane is meridional and divides the blastodisc into two blas-omeres which are roughly circular when viewed from above. As a result the axis f the blastoderm is noticeably elongated at right angles to the cleavage plane fig. 3). The second cleavage, also meridional and at right angles to the first, esults in the restoration of equality in the two axes of the blastoderm. During his process the edges of the blastoderm become more abrupt and by the time four ells are established there is a marked constriction at their bases (fig. 4). urthermore, a large number of the minute oil globules originally scattered over he yolk have become concentrated under the blastomeres and particularly at their dges. The third cleavage takes place on each side of and parallel to the first lane of cleavage, resulting in two parallel rows of four symmetrical blastomeres ach (fig. 5). Thus one axis of the blastoderm is again lengthened.

In the 16-cell stage (fig. 6) the blastoderm once more approaches a circu-ar outline and as segmentation progresses it becomes more and more symmetrical. The individual cells in the 16- and 32-cell stages are irregular in size, form, and position, but as they grow smaller in the subsequent divisions this irregu-larity vanishes. With the fifth cleavage and the formation of 32 cells, the blas-toderm becomes two cells in thickness and further cleavages are difficult to fol-low in living material.

By 24 hours the blastoderm has assumed the form of a thick lenticular cap with very abrupt edges. The individual cells are still readily visible (fig. 7). As development progresses, the blastoderm becomes distinctly dome-shaped, the edges losing their steepness, and at about the same time the cells become so small as to be indistinguishable in the living material. As a result of these changes the entire egg assumes an appearance very similar to that of the fully developed blastodisc stage (fig. 8).

It may be noted here that I have found it impossible to distinguish the periblast in the living egg of *Orthonopias*. Neither have I been able to detect it in the eggs of any other California Cottids that I have examined. This fact indicates that this structure is not strongly developed within the family. How-ever, its invisibility is doubtless partly due to the color and relative opacity of the yolk.

Shortly after the blastoderm has assumed a symmetrical dome shape, the segmentation cavity becomes apparent beneath its central area. In the early stages of its formation, this cavity cannot be distinguished by looking down upon the upper surface of the blastoderm. On the other hand, its solid cellular walls are readily seen and the concave outline of the cavity is quite distinct when the egg is viewed from the side (fig. 9). At this time, about 48 hours after

stripping, the blastoderm is of fairly uniform thickness throughout and its appearance is the same from whichever lateral direction it may be viewed.

As development progresses, the roof of the segmentation cavity grows thinner and due to this and to a proliferation and centripetal migration of the peripheral cells, a thickened cellular rim arises around the edge of the blastoderm. This is the germ ring which, until the closure of the blastopore, marks the advance of the blastoderm over the yolk sphere.

The proliferation of the peripheral cells which results in the formation of the germ ring is much more rapid at one place than around the rest of the periphery of the blastoderm, and as soon as the germ ring has developed to the extent that it may easily be seen, this part of it is found to be wider than the rest. This point marks the posterior pole of the future embryo. Here the very rapid proliferation of cells results in a broad tongue, the embryonic shield, being formed and pushed forward into the segmentation cavity. In the case of *Orthonopias*, the embryonic shield is very wide and may originate along almost half of the germ ring (figs. 10 and 11). Soon a thickening occurs along the median line of the embryonic shield and of the overlying blastoderm. This represents the axis of the embryo. The thickening results in a prominent dorsal ridge protruding into the perivitelline space and in a ventral ridge, causing the formation of a deep V-shaped groove in the yolk in which the embryo lies cradled (fig. 13).

While these changes are taking place, the blastoderm as a whole is increasing in size and gradually investing the yolk. In the eggs of early strippings, the germ ring never attained a diameter equal to that of the yolk sphere. As a consequence there was a marked constriction of the yolk sphere in the region of the germ ring (figs. 12-14), and concomitant with the investment there was evidently a flow of yolk through the germ ring into the enlarging gastrocoele.

At about the time the germ ring formed an equatorial belt around the yolk sphere, the eyes became visible and Kupffer's vesicle put in its appearance embedded in the yolk under the posterior end of the embryo (fig. 13). Shortly thereafter, on the sixth day, segmentation was detected and the pupils of the eyes became visible.

On about the seventh day the blastopore closed and the auditory capsules put in their appearance as a pair of small oval vesicles posterior to the eyes. The heart began to pulsate at about this time and could be seen clearly in a depression in the yolk just posterior to and below the eye. The embryo, still cradled in the groove in the yolk, appeared to be well organized (fig. 15). At the time of the closure of the blastopore, Kupffer's vesicle still persisted but it soon became smaller and a few hours later it disappeared completely.

In the eggs of late strippings certain very marked differences in development occurred in this period between the formation of the germ ring and the closure of the blastopore. Particularly noticeable was the fact that the germ ring increased to such a size that it invested the yolk sphere without the least constriction or distortion of the latter. The growth of the blastoderm was exceedingly precocious when compared with the eggs of early strippings, the blastopore closing on the fifth day instead of on the seventh. Due to this, and to the fact that the embryo itself developed at approximately the same rate as those discussed above, the eggs of late strippings presented a very different appearance than did those of the earlier groups. The blastoderm at the time of the appearance of the segmentation cavity was thinner, covered more of the surface of the yolk, and was flatter than in the eggs stripped on or before March 21 (fig. 16). The segmentation cavity in front of the embryo, as well as the embryo

self was drawn out and flattened by the rapid growth of the blastoderm, and ese structures did not bulge into the conspicuous dome and ridge which charac- rized the earlier batches. A comparison of fig. 10 and fig. 17, which represent e two groups at about the same stage, will indicate the magnitude of the dif- rence between them. By the time the blastopore closed in the later batches, the es and Kupffer's vesicle were just putting in their appearance, while somites d not yet developed (fig. 18). About two days after the closure of the blasto- re, these embryos had reached the same stage that the earlier batches had ached at the time of the closure of the blastopore. From that time on, develop- nt ran parallel in the two groups.

Shortly after the disappearance of Kupffer's vesicle the tail becomes free id begins to lengthen rapidly, twitching spasmodically from side to side at ntervals. Some of the lobes of the brain may be distinguished at this time, and ne segmentation is seen to be progressing caudally (fig. 19).

About the tenth day the eyes, which have increased considerably in size, egin to display a little pigment, becoming increasingly darker as development rogresses. As it lengthens, the tail becomes more active and instead of lying in ne median plane, as it did for a day or two after becoming free, it is flexed to ne right or to the left and passes either in front of the snout or over the ape. The head as a whole, and particularly the auditory capsules in which the toliths are now plainly visible, increase rapidly in size, and the notochord can e distinguished as a relatively transparent rod extending through the trunk and ail. Furthermore, when the embryo moves the continuous fin fold may be detected fig. 20).

A day or so after pigmentation first appears in the eyes, melanophores may e observed developing along the roof of the body cavity (fig. 21). A little ater additional ones are found to occur along the ventral margin of the tail.

As the time for hatching draws near, the entire embryo, particularly the ead, increases gradually in size and assumes more definite outlines, while the olk is reduced to about half its original volume (fig. 22). Some hours before atching, a large number of small granular patches become evident on the head. hese structures are transitory, disappearing within a few minutes after hatching. imilar granular patches have been observed by Eigenmann (1892), Breder (1922), nd other workers in various other species of teleosts. The time of appearance nd the short duration of these patches, coupled with the fact that the embryo is xceedingly active during its last two or three days within the egg, suggest that he granular patches may serve as rasps which are effective in rupturing the egg embrane and liberating the embryo.

It is probable that the pectoral fins are developed at a fairly early tage, but they can not be distinguished in the living material until about one ay before hatching, at which time they are well developed and actively used.

Incubation at laboratory temperature (about 13°C.) occupies 16 to 19 days. hen newly hatched, the larvae vary considerably in size, measuring from 2.9 to .8 mm. in standard length. The yolk sac remains relatively large and globular, nd the head is not markedly deflected. The dorsal fin fold has its origin at the ape and is continuous with the ventral fin fold which originates immediately osterior to the anus. The depth of each fin fold is approximately equal to the epth of the body behind the anus (fig. 23). There is a patch of heavy round elanophores, all closely approximated but distinct from each other, overlying he body cavity. This forms a broad shield-shaped pattern of black spots when een from above (fig. 24), but when seen from the side it appears as a curved and of dots shading into a solid black bar dorsally. There is a streak of small

elongated melanophores, about 35 in number, lying along the ventral surface of the tail. This streak originates a short distance behind the anus and ends at about the same distance from the tip of the tail. In some individuals it is continued posteriorly by three or four small melanophores on the fin fold, but in others the fin fold is entirely without pigment. The interorbital region and the nape, which are pigmentation centers in other Cottids, are usually unpigmented in *Orthonopias*, although occasional individuals may display a large but rather pale melanophore over one eye. The yolk sac, which is of a pale brownish color, is covered by a well developed vascular network. It is transparent enough to permit the liver and bile sac to be made out, and the persistent oil globule is clearly visible. At the time of hatching, the larvae are very active and are able to swim with considerable vigor. Their movements seem to be well controlled, the jaws are well developed and the mouth seems to be functional.

Although several methods of aeration and feeding were tried, none were successful and all of the larvae died within ten days. During the short period of their survival they increased about 0.2 mm. in length and absorbed their yolk sacs. Within a week the oil globule disappeared and melanophores developed in the interorbital region and on the nape. No other important changes took place, the appearance of the entire fish remaining approximately the same as at the time of hatching (fig. 25).

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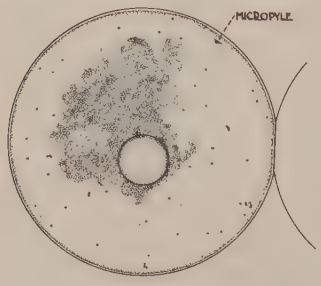

FIG. 1

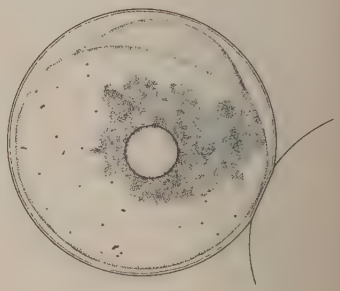

FIG. 2

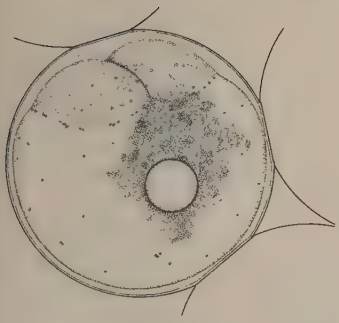

FIG. 3

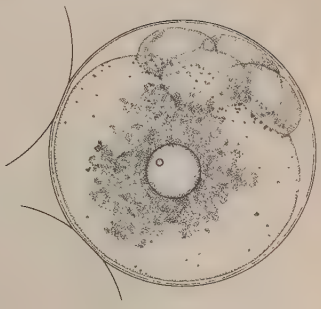

FIG. 4

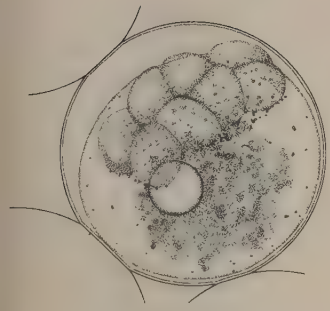

FIG. 5

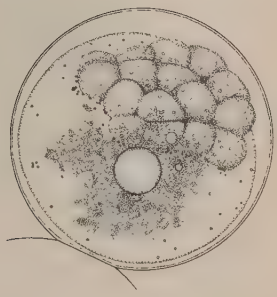

FIG. 6

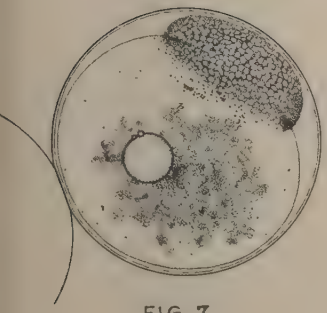

FIG. 7

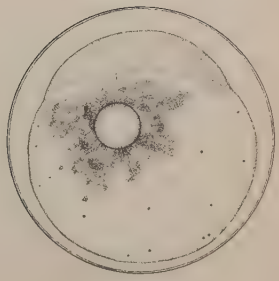

FIG. 8

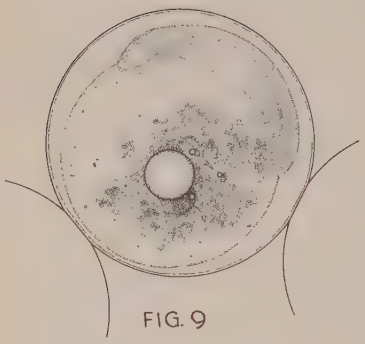

FIG. 9

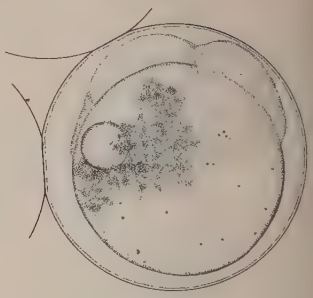

FIG. 10

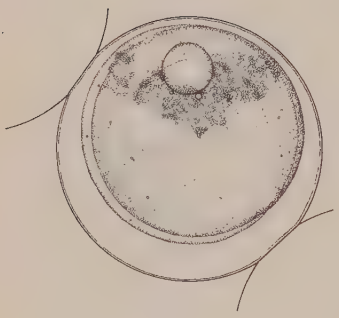

FIG. 11

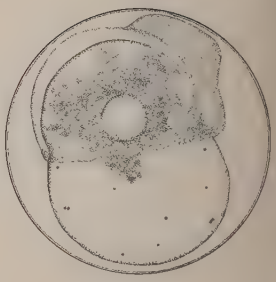

FIG. 12

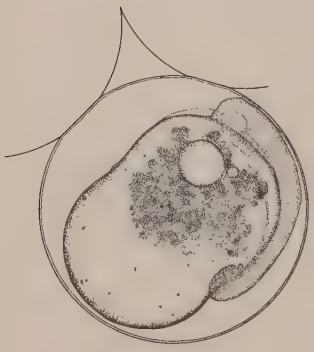

FIG. 13

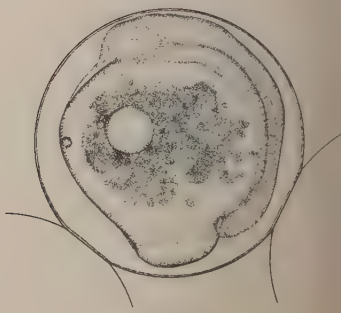

FIG. 14

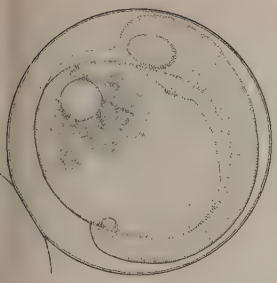

FIG. 15

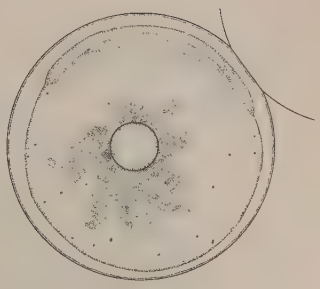

FIG. 16

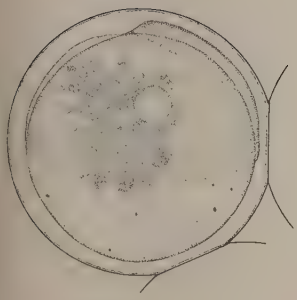

FIG. 17

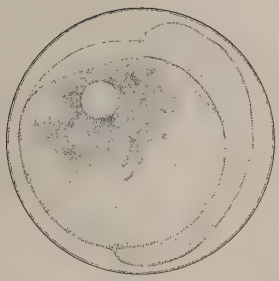

FIG. 18

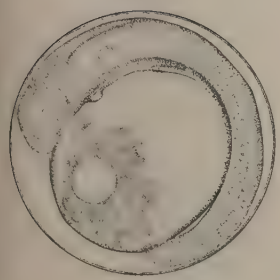

FIG. 19

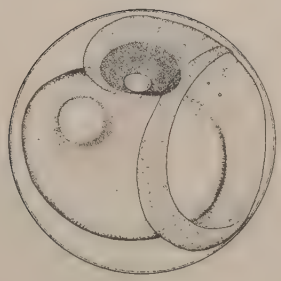

FIG. 20

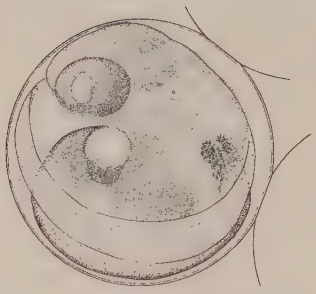

FIG. 21

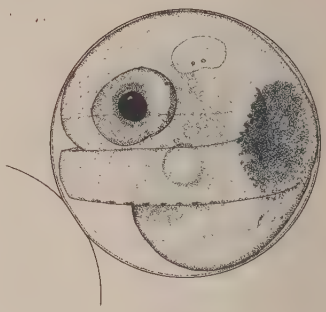

FIG. 22

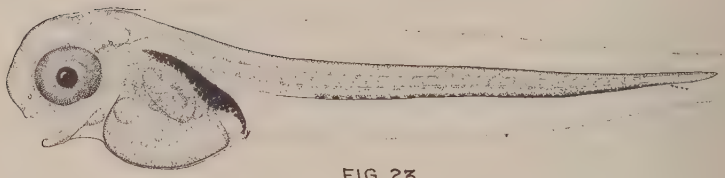

FIG. 23

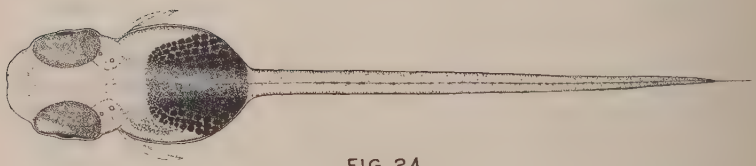

FIG. 24

FIG. 25

SYNOPSIS OF THE GENERA OF PIMELODID CATFISHES WITHOUT A FREE ORBITAL RIM

By William A. Gosline

The Pimelodid catfishes without a free orbital rim form a focal point of 'usion in South American systematic ichthyology. The difficulties with the as-)lage are several. For the most part the species are small and have been in-)uately described by various authors throughout the scattered literature of last thirty years. The genera have usually been loosely defined, and the spe-s have been generically misplaced more often than not. The group itself, as)n pointed out in 1911 (Ann. & Mag. Nat. Hist., ser. 8, vol. 8, p. 572), is)ably of polyphyletic origin, and the lack of a free orbital rim, the character)h separates these fishes from the rest of the Pimelodids, is not as definitive)ne might wish.

All these difficulties became abundantly clear to me in the course of pre-ing a catalogue of the fresh-water catfishes of South America. Nevertheless, naterial is to be identified, something must be done with the group. The present)r is written in the hope of preventing an even more chaotic state from de-)ping until such time as a more thorough revision is made.

What seems to be the most orderly start in the classification of these gen- was made by Eigenmann in 1912 (Mem. Carnegie Mus., vol. 5, p. 130). The fol-ing key to the genera is based on that classification. All species of Pimel-ds without free orbital rim including the three blind forms are dealt with in paper, and each has been allotted to its proper genus, so far as is now pos-le. Original citations of all genera are given; included species are cited under ir original names.

SYNOPSIS OF THE GENERA

Eye degenerate, completely covered with flesh, invisible from exterior; maxillary barbels reaching tip of pectorals or beyond; anal rays 9 to 15; caudal forked.

. Occipital process not meeting predorsal plate; anal rays 9 to 11.

a. Fontanel reaching base of occipital process; occipital process spear-shaped; distance of adipose from dorsal greater than dorsal base...1. *Caecorhamdella.*

b. Fontanel not extending behind eye; distance of adipose from dorsal less than dorsal base.....2. *Caecorhamdia.*

. Occipital process meeting predorsal plate; anal rays 12 to 15 .....3. *Typhlobagrus.*

Eye normal, but small and without free margins.

. Dorsal spine well developed, pungent; body not elongate; head about as broad as long.

a. Dorsal surface of the skull covered with thin skin; origin of ventrals behind middle of body, except sometimes in the young.

6a. Lower jaw projecting beyond upper; fore-part of head broad and greatly flattened.

7a. Top of head with bony ridges; occipital crest exposed; adipose fin an exceedingly low ridge, about the diameter of the eye in height .....4. *Lophiosilurus.*

7b. Top of head smooth; occipital crest not exposed; adipose fin well developed, of normal height.....5. *Cephalosilurus.*

6b. Lower jaw not projecting beyond upper; fore-part of head not excessively flattened.
8a. Premaxillary teeth with a backwardly projecting angle...6. *Pseudopimelodus*
8b. Premaxillary teeth without a backwardly projecting angle....7. *Microglanis*
5b. Dorsal surface of skull covered with a thick layer of muscle; origin of ventrals in front of middle of body.....8. *Brachyglanis*
4b. Dorsal spine small or replaced by a soft ray, not pungent.
9a. Pectoral spine strong but short; skull covered with a thick layer of muscle; anal rays 17 or more.....9. *Myoglanis*
9b. Pectoral spines weak or absent.
10a. Anal rays 18 to 28.
11a. Head conical; body deep, heavy; ventrals under posterior dorsal rays .....10. *Rhamdiopsis*
11b. Head more or less depressed; body elongate.
12a. Caudal forked.....11. *Acentronichthys*
12b. Caudal rounded.....12. *Heptapterus*
10b. Anal short, of about 11 rays.
13a. Head conical; ventrals under posterior dorsal rays; caudal deeply forked .....13. *Cetopsorhamdia*
13b. Head depressed.
14a. Caudal lanceolate; ventrals reaching to center of anal..14. *Nemuroglanis*
14b. Caudal not lanceolate; ventrals not reaching center of anal.
15a. Cheeks, preopercle, and opercle covered with thin skin...15. *Imparfinis*
15b. Cheeks, preopercle, and opercle fleshy.
16a. Premaxillary teeth without a backwardly projecting angle .....16. *Pariolius*
16b. Premaxillary teeth with a backwardly projecting angle .....17. *Chasmocranus*

1. Genus *CAECORHAMDELLA* Borodin

Caecorhamdella Borodin, 1927, American Mus. Novitates no. 263, p. 1 (genotype by original designation *Caecorhamdella brasiliensis* Borodin).

Caecorhamdella brasiliensis Borodin, 1927, State of São Paulo, Brazil

2. Genus *CAECORHAMDIA* Norman

Caecorhamdia Norman, 1926, Ann. & Mag. Nat. Hist., ser. 9, vol. 18, p. 325 (genotype by monotypy *Caecorhamdia urichi* Norman).

Caecorhamdia urichi Norman, 1926, Trinidad.

3. Genus *TYPHLOBAGRUS* Miranda Ribeiro

Typhlobagrus Miranda Ribeiro, 1907, Kosmos, anno 4, no. 1 (genotype by monotypy *Typhlobagrus kronei* Miranda Ribeiro).

Typhlobagrus kronei Miranda Ribeiro, 1907, Rio Iporanga, State of São Paulo, Brazil.

4. Genus *LOPHIOSILURUS* Steindachner

hiosilurus Steindachner, 1876, Sitz. Akad. Wiss. Wien, math.-naturw. Classe, l. 74, p. 154 (genotype by monotypy *Lophiosilurus alexandri* Steindachner).

Lophiosilurus alexandri Steindachner, 1876, Rio São Francisco, Brazil.

5. Genus *CEPHALOSILURUS* Haseman

halosilurus Haseman, 1911, Ann. Carnegie Mus., vol. 7, p. 317 (genotype by monoypy *Cephalosilurus fowleri* Haseman).

Cephalosilurus fowleri Haseman, 1911, Rio São Francisco, Brazil. *Pimels bufonius* Cuvier and Valenciennes, 1840, Cayenne. *Pimelodus mangurus* Cuvier Valenciennes, 1840, Brazil and Paraguay.

6. Genus *PSEUDOPIMELODUS* Bleeker

udopimelodus Bleeker, 1858, Ichth. Archip. Indici, I, Siluri, p. 196 (genotype y subsequent designation of Bleeker, 1862, Atlas Ichth. Indes Orientales Nérlandaises, vol. 2, p. 11, *Pimelodus raninus* Cuvier and Valenciennes).
rachoglanis Gill, 1858, Ann. Lyceum Nat. Hist. New York, vol. 6, p. 389 (genoype by original designation *Pimelodus raninus* Cuvier and Valenciennes).

Pimelodus raninus Cuvier and Valenciennes, 1840, "Mana", possibly the river that name in French Guiana. *Pseudopimelodus acanthochira* Eigenmann and Eigenn, 1888, Lower Amazon. *Pseudopimelodus villosus* Eigenmann, 1912, British Guiana. *udopimelodus albomarginatus* Eigenmann, 1912, British Guiana. *Pseudopimelodus nsmontanus* Regan, 1913, San Juan and Patia basins, Colombia. *Pseudopimelodus iolosus* Miranda Ribeiro, 1914, Rio Taquary, State of Matto Grosso, Brazil. *Pseudimelodus roosevelti* Borodin, Parassununga, State of São Paulo, Brazil; this cies differs from others of the genus in having a "leathery" tip to the pectoral nes, in this respect resembling *Pimelodus bufonius* and *mangurus* of Cuvier and enciennes.

7. Genus *MICROGLANIS* Eigenmann

roglanis Eigenmann, 1912, Mem. Carnegie Mus., vol. 5, p. 155 (genotype by original designation *Microglanis poecilus* Eigenmann).

Microglanis poecilus Eigenmann, 1912, British Guiana. *Pseudopimelodus parabae* Steindachner, 1880, Rio Parahyba, State of Rio de Janeiro = *Pseudopimelodus urus* Steindachner, 1876, non Cuvier and Valenciennes. *Pimelodus (Pseudopimelodus) lcher* Boulenger, 1887, Canelos, Ecuador. *Pimelodus (Pseudopimelodus) cottoides* ulenger, 1891, Camaquam River, State of Rio Grande do Sul, Brazil. *Microglanis riegatus* Eigenmann and Henn, 1914, Vinces, north of Guayaquil, Ecuador. *Microanis ater* Ahl, 1936, "Mittelbrasilien."

8. Genus *BRACHYGLANIS* Eigenmann

Breviglanis Eigenmann, 1910, Repts. Princeton Univ. Exped. Patagonia, vol. 3, p. 384 (nomen nudum and preoccupied).
Brachyglanis Eigenmann, 1912, Mem. Carnegie Mus., vol. 5, p. 156 (genotype by original designation *Brachyglanis frenata* Eigenmann).

Brachyglanis frenata Eigenmann, 1912, British Guiana. *Brachyglanis mela* Eigenmann, 1912, British Guiana. *Brachyglanis phalacra* Eigenmann, 1912, Britis Guiana. *Brachyglanis nocturnus* Myers, 1928, Rio Negro, State of Amazonas, Brazil

9. Genus *MYOGLANIS* Eigenmann

Myoglanis Eigenmann, 1910, Repts. Princeton Univ. Exped. Patagonia, vol. 3, p. 38 (nomen nudum); Eigenmann, 1912, Mem. Carnegie Mus., vol. 5, p. 159 (genotype b original designation *Myoglanis potaroensis* Eigenmann).
Leptoglanis Eigenmann, 1910, Repts. Princeton Univ. Exped. Patagonia, vol. 3, p. 384 (nomen nudum and preoccupied); Eigenmann, 1912, p. 158 (type *Leptoglani essequibensis* Eigenmann).
Leptorhamdia Eigenmann, 1918, Mem. Carnegie Mus., vol. 7, p. 260 (substitute fo *Leptoglanis*, same type).

Myoglanis potaroensis Eigenmann, 1912, British Guiana. *Leptoglanis esse quibensis* Eigenmann, 1912, British Guiana. *Heptapterus collettii* Steindachner 1881, Maldonado, Uruguay. *Leptorhamdia marmorata* Myers, 1928, Rio Negro, Stat of Amazonas, Brazil.

10. Genus *RHAMDIOPSIS* Haseman

Rhamdiopsis Haseman, 1911, Ann. Carnegie Mus., vol. 7, p. 375 (genotype by monotyp *Rhamdiopsis moreirai* Haseman).

Rhamdiopsis moreirai Haseman, 1911, Rio Iguassu, State of Santa Catharina, Brazil.

11. Genus *ACENTRONICHTHYS* Eigenmann and Eigenmann

Acentronichthys Eigenmann and Eigenmann, 1889, Proc. California Acad. Nat. Sci., ser. 2, vol. 2, p. 29 (genotype by original designation *Acentronichthys leptos* Eigenmann and Eigenmann).

Acentronichthys leptos Eigenmann and Eigenmann, 1889, São Mattheos, State of Espiritu Santo, Brazil.

12. Genus *HEPTAPTERUS* Bleeker

Heptapterus Bleeker, 1858, Ichth. Archip. Indici, I, Siluri, p. 197 (genotype by

bsequent designation of Bleeker, 1862, Atlas Ichth. Indes Orientales Néer-ndaises, vol. 2, p. 15, *Pimelodus mustelinus* Cuvier and Valenciennes).

Pimelodus mustelinus Cuvier and Valenciennes, 1840, La Plata basin. *Hep-erus surinamensis* Bleeker, 1864, Surinam; it is impossible to tell whether species belongs here or in *Acentronichthys*, as the tail of Bleeker's specimen roken. *Heptapterus eigenmanni* Steindachner, 1907, Maldonado, Uruguay =*Heptap-s mustelinus* Eigenmann and Eigenmann, 1890, non Cuvier and Valenciennes. *Hep-erus multiradiatus* von Ihering, 1907, Alto da Serra, State of São Paulo, Bra- *Heptapterus fissipinnis* Miranda Ribeiro, 1911, Rio Estrella basin, State of Grande do Sul, Brazil. *Heptapterus stewarti* Haseman, 1911, Rio Iguassu, State anta Catharina, Brazil. *Heptapterus ornaticeps* Ahl, 1936, Rio de Janeiro.

13. Genus *CETOPSORHAMDIA* Eigenmann and Fisher

psorhamdia Eigenmann and Fisher, in Eigenmann, 1916, Ann. Carnegie Mus., vol. , p. 83 (genotype by monotypy *Cetopsorhamdia nasus* Eigenmann and Fisher).

Cetopsorhamdia nasus Eigenmann and Fisher, 1916, Honda, Colombia. *Impar-s mirini* Haseman, 1911, Piracicaba, State of São Paulo, Brazil. *Imparfinis diosus* Steindachner, 1915, Rio Branco basin, State of Amazonas, Brazil. *Impar-s hasemani* Steindachner, 1915, Rio Branco basin, State of Amazonas, Brazil. *psorhamdia boquillae* Eigenmann, 1922, Cauca basin, Colombia.

14. Genus *NEMUROGLANIS* Eigenmann and Eigenmann

uroglanis Eigenmann and Eigenmann, 1889, Proc. California Acad Sci., ser. 2, l. 2, p. 29 (genotype by original designation *Nemuroglanis lanceolatus* Eigen-nn and Eigenmann).

Nemuroglanis lanceolatus Eigenmann and Eigenmann, 1889, Rio Jutahy, a trib-y of the middle Amazon; it is impossible to tell from the Eigenmanns' descrip- whether this species has a free orbital rim or not.

15. Genus *IMPARFINIS* Eigenmann and Norris

rfinis Eigenmann and Norris, 1900, Revista do Museu Paulista, vol. 4, p. 352 genotype by monotypy *Imparfinis piperatus* Eigenmann and Norris).
ndioglanis von Ihering, 1907, Notas Preliminares da Museu Paulista, vol. 1, . 16 (genotype by monotypy *Rhamdioglanis frenatus* von Ihering).

Imparfinis piperatus Eigenmann and Norris, 1900, State of São Paulo, Bra-; synonyms: *Rhamdioglanis frenatus* von Ihering, 1907, and *Rhamdioglanis trans-piatus* Miranda Ribeiro, 1908. *Nannoglanis hoehnei* Miranda Ribeiro, 1914, Rio uary, State of Matto Grosso, Brazil. *Imparfinis microps* Eigenmann and Fisher, 5, Rio Negro at Villavicencio, Colombia; this is a strange-looking fish which haps belongs in another genus. *Imparfinis bolivianus* Pearson, 1924, Beni River in, Bolivia.

16. Genus *PARIOLIUS* Cope

Pariolius Cope, 1872, Proc. Acad. Nat. Sci. Philadelphia for 1871, p. 289 (ge type by monotypy *Pariolius armillatus* Cope); Gosline, Copeia, 1940, p. 79.
Nannoglanis Boulenger, 1887, Proc. Zool. Soc. London for 1887, p. 278 (genoty by monotypy *Nannoglanis fasciatus* Boulenger).

Pariolius armillatus Cope, 1872, Ampiyacu River, Peru. *Nannoglanis fa ciatus* Boulenger, 1887, Eastern Ecuador; Boulenger's description does not sta whether this species has backwardly projecting angles at the end of the prema illary teeth or not. *Nannoglanis bifasciatus* Eigenmann and Norris, 1900, Sta of São Paulo, Brazil; another species in which the shape of the premaxillary too row is not stated. *Imparfinis hollandi* Haseman, 1911, Rio Iguassu, State of San Catharina, Brazil; shape of tooth rows not stated. *Chasmocranus rosae* Eigenman 1922, Rio Meta basin, Colombia. *Imparfinis longicauda* Borodin, 1927, Rio Gran do Sul, State of São Paulo, Brazil; shape of tooth rows not stated.

17. Genus *CHASMOCRANUS* Eigenmann

Chasmocephalus Eigenmann, 1910, Repts. Princeton Univ. Exped. Patagonia, vol. p. 384 (nomen nudum and preoccupied).
Chasmocranus Eigenmann, 1912, Mem. Carnegie Mus., vol. 5, p. 160 (genotype by or ginal designation *Chasmocranus longior* Eigenmann).

Chasmocranus longior Eigenmann, 1912, British Guiana. *Chasmocranus brevi* Eigenmann, 1912, British Guiana. *Chasmocranus truncatorostris* Borodin, 1927, Co onia Hansa, Joinville, State of Santa Catharina, Brazil. *Chasmocranus quadrizonat* Pearson, 1937, upper Marañon; shape of premaxillary tooth row not stated.

A NEW NAME FOR *TAENIONEMA*, A GENUS OF AMAZONIAN SILUROID FISHES

By George S. Myers

Taenionema Eigenmann and Bean 1907 (Proc. U.S. Nat. Mus., vol. 31, p. 6 type by original designation *T. steerei* Eigenmann and Bean) is a homonym of *T nionema* Banks 1905 (Psyche, vol. 12, nos. 3-4, p. 56), a plecopteran from Colorad Eigenmann and Bean's name may be replaced by the new name *Goslinia*, in recogniti of the fine work of Dr. William Alonzo Gosline III on South American Siluroid The definition of *Goslinia* is that given by Eigenmann and Bean for *Taenione* and the genotype is the same. The only species is the large, Lower Amazonian ca fish, *Goslinia platynema* Boulenger 1898 (Ann. & Mag. Nat. Hist., ser. 7, vol. p. 477), of which *steerei* appears to be a synonym.